ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 63. No. 12. 220 Broadway, New York, March 24, 1910.

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The Engineering Features of the Recent Floods in Paris.

During the last part of January and the first of February of the present year a peculiar combination of meteorological conditions brought about in the Seine River in France an exceedingly heavy flood which caused great distress in the country districts in the upper part of the river but which culminated at the narrowed waterway at the city of Paris and produced there a flood height in excess of all but one recorded high water in the history of the city. The Seine, rising some 28 ft. above its mean level, backed up into the sewers and subways, overtopped the retaining quay walls and flooded large areas of residential and business districts adjoining the river. The details of the fight against the flood and its effect on the activities of the residents are probably familiar to all our readers through the contemporary press dispatches, but there are a number of features of more than ordinary engineering interest connected with the behavior of structures and the causes of the inundation which are worthy of recording now. Even at this time it is impossible to report upon the real effect of the flood on the foundations and structures of Paris. Slowly the water which filled the sub-surface openings is being pumped out and more slowly the raised ground water level is receding and it will be some considerable time before an authentic report can be made on the condition of the sub-surface structures.

THE INTERIOR OF THE GARE DES INVALIDES. WAITING ROOM OF THE STATION FLOODED.

The drainage area of the Seine comprises about 30,370 sq. miles, and is divided in its upper reaches into two main branches, each divided into smaller tributaries. These are the Marne and Haute-Seine, stretching to the east and northeast, and the Yonne, extending southeast to the plateaus and mountains of Morvan. The former is a gradually sloping country, of an extremely pervious formation into which the rain easily soaks, so that the run-off from rainfall is very slow; the latter is in a granitic formation and at its headwaters is on a mountain slope from which the rainfall passes to the river rapidly and with little loss. The atmospheric conditions over the whole area are generally the same, that is, a rainstorm will extend from the ocean to the mountains, or a dry spell will be prevalent in all parts. Observations show that the rainfall in the basin varies inversely as the distance from the ocean and directly to the altitude, but that the storms in the upper reaches of the river are generally widespread and of uniform intensity.

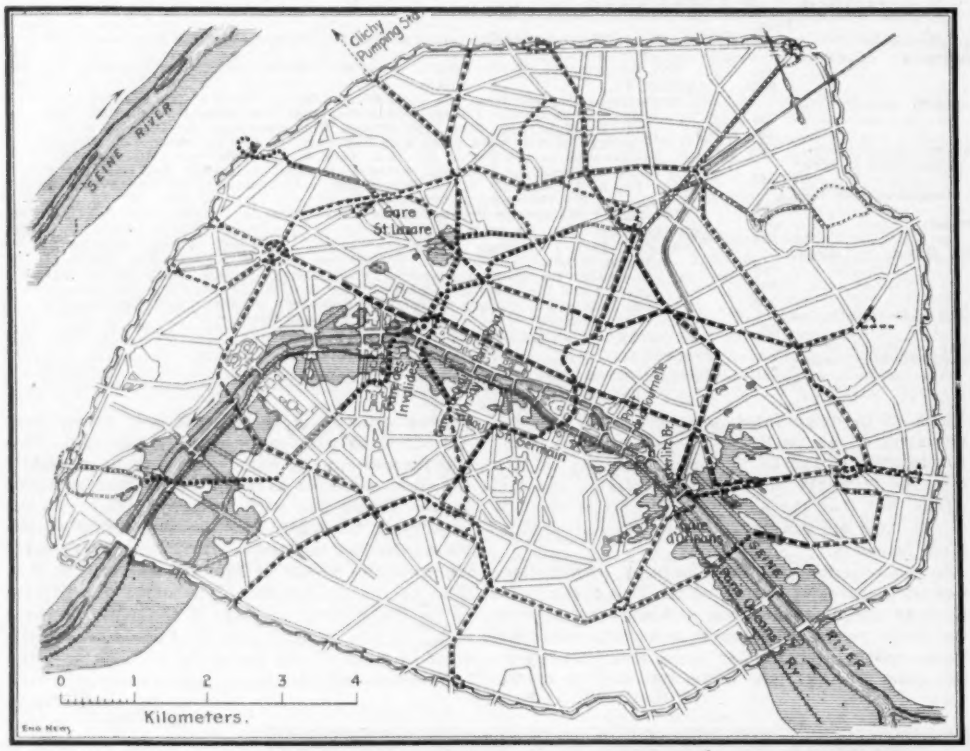
In consequence of this uniform distribution and of the diverse nature of the two upper portions of the drainage area, a heavy storm over the basin generally produces a certain result in Paris, which is 135 miles on a direct line and 226 miles via the river from the sea, or about half-way from the sea to the farthest distant parts of the drainage area. This result, observed through many years, is that the waters from the Yonne first reach Paris and raise the level of the Seine there, and that they are followed some four or five days later by the waters of the Marne which, as before noted, takes that much longer to be affected by the rainfall.

The three winter months, December, January and February, this season in France have been the rainiest in the past 40 years and the fourth rainiest in the century 1811-1910. In spite of this there have been no excessive storms, but only a steady, almost daily, fall of rain. Thus around Paris in December 2.84 ins. fell, as against a normal fall of 1.76 ins., in January 2.96 ins. against 1.58 and February 2.68 against 1.24, a total in the three months of 8.58 ins., when ordinarily the fall is only 4.56 ins. In February at Paris there were only seven days out of the 28 when some rain did not fall. This rainy condition, as noted above to be generally the case, extended over the entire drainage area of the Seine, but with different effects in the two upper branches. In the mountains of the Yonne district the temperature during the winter up to the middle of January was low, so that most of the precipitation was snow, which piled up on the Morvan plateaus to the depth of three feet. In the district around Paris and on the Marne branch of the Seine, on the contrary, the temperature for the season was abnormally high and all the precipitation was rain which soaked the porous ground to the saturation point and raised the ground water level to a dangerous height.

Thus about Jan. 15 we have the following condition: the ground near the Marne and its branches saturated with water so that it could hold no more, the subsoil at Paris in a saturated state and the plains and mountains of Morvan covered with snow. At this time a thaw set in on the Yonne and rain commenced to fall there, and the run-off rapidly reaching the Yonne, started down the river toward Paris. From then on until March, warm periods, with rain and consequent thaws, alternated with cold spells which stopped the excessive run-off for a time. About this same time, too, the sub-surface in the northeastern branches of the river had about reached a point where it could hold no more water and the run-off into the stream began to approximate the rainfall in amount.

The effect at Paris can be followed from the flood curve shown in Fig. 3. Beginning on Jan. 19, the floods from the fast rising Yonne began to arrive and swell the river already rising from the general run-off from the rain-soaked lower river. These floods from the Yonne increased until about Jan. 22, when they were reduced by the freezing up of the mountain district on Jan. 21 and 22. It seemed at this time at Paris that a fall of the flood height could be expected when the water from the slowly moving Marne and Haute-Seine reached Paris some four days after the floods from the Yonne caused by the same conditions over the whole area. Again on Jan. 23-25 another warm spell appeared on

the Yonne and its rapid run-off and flow precipitated another flood on Paris, joining there with the steady flow now coming down from the Marne. These last two combined on Jan. 28 to form the crest of the flood. From then on the waters fell until Feb. 7 when a recurrence of the alternate warm and cold weather brought about another rise, but on account of the lack of snow and the small rainfall the height of the flood was much smaller. After Feb. 11 this occurrence was repeated on a smaller scale at least twice, and at present it seems that normal stages in the river cannot be expected until late spring. The cause of the flood was, then, the recurrence of warm weather and rains which allowed the concurrence of floods from two rivers which ordinarily would follow each other. The great height of the water at Paris was due also to other causes, namely, the saturated condition of the sub-soil around about the city due to a rainy and snowy winter, the very gentle slope of the Seine from Paris to the sea, and the excessive number of bends in the river (both of which prevented the water from flowing away rapidly), and finally by the great number of obstructions to the river's course in the way of bridges in the city proper.



Operating Subway { Clear, Flooded } Subways under Construction { Clear, Flooded }

FIG. 2. MAP OF PARIS SHOWING EXTENT OF THE FLOODS IN JANUARY AND FEBRUARY.
(Flooded area shown shaded. Those steam railways only are shown which immediately adjoin the river.)

Paris lies at an elevation varying from 25 to 128 m. above mean sea level, and the mean water level of the Seine, which varies somewhat in its gradual slope through the city is from +26.0 to +27.5 m. By far the greater portion of the streets adjoining the river are at an elevation higher than the mean level of the water, but in a number of places such is not the case, and the land, with its streets and dwellings, is protected from the river only by the quays, which, as a rule, are about 3 m. above the mean level. In addition there are along the river side of these masonry quays a number of openings, either for sewers or for subway ventilation, which permitted the entrance of the water to the town some time before they overtopped the quay walls. Finally, however, the height reached a point above the quay walls and all the regions adjoining the river up to an elevation of about +34.7 were inundated.

The daily record of the flood is shown in Fig. 3. Some explanation of the method of taking these measurements is necessary. As is well known, the two parts of Paris on either bank of the Seine are connected by 26 bridges, some of most massive construction, dating back to the middle ages, and others of the more slender types of today. For ordinary water these bridges do not constitute an obstruction to the river, except in so far as their piers fill up the channel, but as they are for the most part arches, the free waterway underneath the bridges decreases rapidly as the water rises. Especially is this so in the case of the masonry arches with solid spandrel walls, and even in the case of the steel arches with column roadway supports the obstruction to the waterway is marked. As an example of the backing up of the water behind these bridges we find the following differences in elevation of the Seine before and during the flood on the Pont d'Austerlitz, at the upper or entering end of the city, and the Pont Royal, about 2 miles downstream. (Fig. 2.)

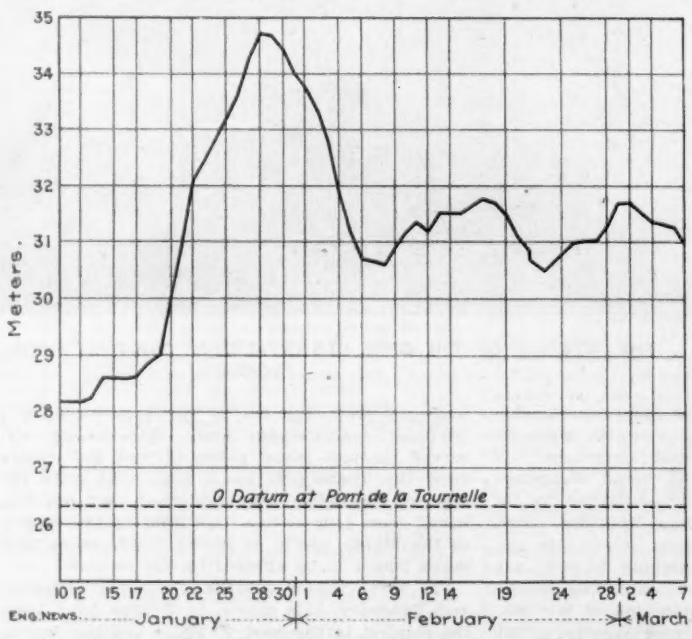


FIG. 3. DIAGRAM OF FLOOD LEVEL AT THE PONT DE LA TOURNELLE.

Bridges.	Elevations in meters—Before flood.	During flood.
d'Austerlitz	28.14	34.86
Royal	27.62	33.81
Difference	0.52	1.05

It is thus seen that the difference in elevation before and during the flood was 19 ins., most of which was due to the 9 bridges intervening between the two places of record.

For purposes of record not only of this one flood but also to compare with past inundations, it is necessary to confine the observations of height to one point. The best location for this seems to be the Pont de la Tournelle, which was in existence in 1658 and has marked upon it the record of the enormous flood of that year. All elevations given in this article are for this bridge, which is in the upper part of the river just above the Ile de la Cité; it is the sixth in order of the 26 bridges across the Seine inside of Paris. The maximum altitudes reached at this bridge by the famous floods of the past are as follows:

	Meters.
Mar. 1, 1658	35.60
Dec. 26, 1740	34.26
Jan. 3, 1802	33.72
Mar. 3, 1807	32.16
Feb. 8, 1850	32.34
Sept. 28, 1866	31.40
Dec. 17, 1872	32.14
Mar. 7, 1876	32.50
Dec. 8, 1882	32.10
Jan. 7, 1883	32.20
Jan. 28, 1910	34.71

The zero of the Pont de la Tournelle scale is at elevation +26.28 m. So the top of the 1910 flood indicates a height of 8.43 m., or 27.6 ft. above normal, a record for 252 years. This zero is the normal established three centuries ago, however, and is not necessarily exact for the present state of the river. It may be seen that floods approximating the recent ones are comparatively common; that is, in the past half-century there have been six floods when the level of the water has passed the elevation of +32 m., which, it will be noted hereafter, is the elevation of a number of the openings into the streets and the railway structures.

No record measurement of the flood discharge has as yet been published by the French authorities, but from the comparative flood heights on one of the bridges it has been estimated, and the estimate is given as close, that the discharge on Jan. 27 was about 83,500 cu. ft. per sec. The maximum discharge previously measured was 58,000 cu. ft. per sec. in 1876. For the floods of the 17th and 18th centuries no discharge measurements are available.

By far the greatest damage done by the floods to individuals was in the suburbs of Paris which adjoin the Seine above the city. This area is very low-lying, so that the waters spread back for a great distance from the banks covering large residential and manufacturing districts. It was here that the hardships of flood time were felt most, because the families were for the most part of the workingman class, whose whole fortune was in the residences destroyed or at least flooded. The slow rise of the waters, however, gave ample warning to the residents and the loss of life throughout the city and suburbs was surprisingly small. In the city proper the districts adjoining the river, fortunately for the individual, are given over largely to public buildings and parks or utilities, and to residences of the finer sort, the owners of which could well afford any damage incurred. Here the damage is mostly to be found in the railway tunnels and terminals, the subways and the sewer and water services. The flooding of power plants where the machinery floor was below the flood height was another very marked cause of damage, both in its effect on the service of the city during the flood and on the efficiency of the plant in the future.

BRIDGES AND QUAY WALLS.—It is a last-

ing testimonial to the bridge builders of Paris that every single one of the 26 bridges across the Seine within the borders of the city stood intact against the pressure of the rushing waters, although in some cases these waters overtopped the roadway. At one time it was thought that the Pont d'Alma, a masonry arch, would have to be dynamited to clear the waterway, but the flood subsided before the need became imperative. Fig. 4 is typical of the stage of water resisted by the arches. This is a view of the Pont Henri IV at the upper end of the river some time

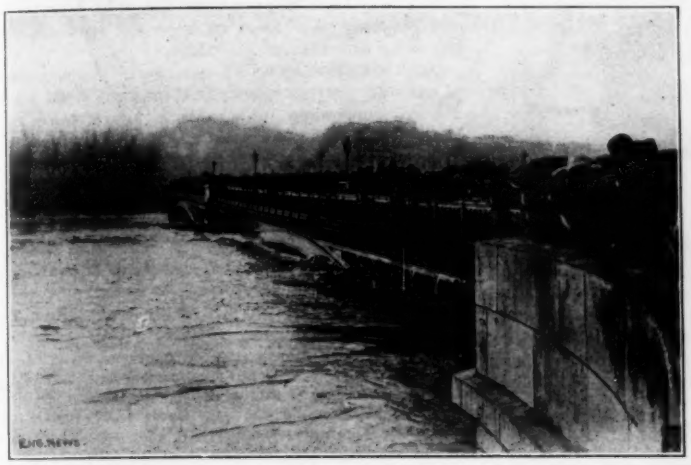


FIG. 4. CROWD ON THE PONT HENRI IV. WATCHING THE FLOOD.

before the crest of the flood was reached. It is a skeleton structure through whose spandrels the water could flow more or less freely; the pressure on the solid wall masonry arches can be imagined. Evidently from this view, and a number of other similar ones that we have seen, the Parisian populace had great faith in its engineers.

The banks of the river are retained with masonry walls, backed with the earth of quays and surmounted with parapet walls. The higher stages of the floods were above the level of the quays and the parapet walls were in many places protected by sand bag embankments such as are shown in Fig. 5. But even this was of no avail, for the water eventually overtopped even the parapets and flowed down into the streets of the city. As related hereafter, the streets were also flooded by water backing up through various openings, and in all these instances great efforts were made by the citizens and by the soldiers to dike off certain districts with cement and sand or dirt barricaded across a street. These efforts were partially successful, but it is probable that the level of the flood in the city followed pretty closely the contour of its height in the river. This contour is shown shaded on the map in Fig. 2.

SEWER AND WATER SYSTEM.—As noted in the article on the "Water Supply, Sewerage and Subways of Paris," by Mr. George A. Soper, in our issue of Feb. 3, 1910, p. 145, the larger part of the sewage of Paris flows either by gravity or under pumping to the central station at Clichy, on the banks of the Seine at the northwestern part of the city, there to be pumped across the river to various sewage farms. The capacity of the pipe under the river is necessarily limited so that in case of excessive rainfall in the city a part of the flow at Clichy is diverted into the Seine. Unfortunately, this divertor was not provided with a check valve, so that when its mouth was covered by the rising waters of the flood, the direction of the flow was reversed and the main and secondary sewers of the city were filled, up to the level of the flood, with river water under pressure. Although the conduits were not designed for this interior pressure there are few instances where there were failures. In these few cases the sewers burst and flooded neighboring ground and cellars with their offensive contents. In the main, however, the Clichy station worked surprisingly well and passed the city's sewage to the respective farms. From other causes the sewers of the city were in many cases broken, as will be explained below.

So far as can be ascertained, the water-supply system of the city did not suffer except where the pipes were located in sewers that burst (See Soper's article) or were in a district where some other cause produced fracture. The filter plants were not flooded. In some cases the simultaneous breaking of adjacent water and sewer pipes or the flooding of a water pipe with sewage from a fractured sewer caused some fear as to the pollution of the water, but such instances were not general enough to cause any widespread danger.

One of the most frequent causes of damage was in the numerous discarded sewers which at one time emptied sewage into the Seine. The ends of these conduits in a number of places were left uncovered in the quay wall and formed a free passage for the river water into the heart of the city long before the quay wall was topped. Under the pressure of several meters of water from the flooded river these pipes often broke and flooded the subsoil to the detriment of the adjacent foundations. In places where these dead pipes were provided with openings into the streets, and where the street level was lower than the excessive height of the river, fountains of water spurted from the openings. This occasionally flooded districts far back from the river which would not have been affected had the pipe openings in the quay walls been closed.

RAILWAYS.—A number of the suburban and through railway lines enter Paris on surface tracks along the banks of the Seine to stations of comparatively low elevation. In every case these roads were flooded, the stations filled with water and travel on the roads either stopped entirely or transferred to some other road. The first page view shows the Gare des Invalides filled with water about the same level as that of the nearby river.

These main roads were put out of service merely because their tracks were below the flood level and were, therefore, covered with the flood. The Paris-Orleans line, on the contrary, was of different construction, and its flooding was due to different causes. This line enters Paris from the southeast and parallels the river, some hundred yards back from the banks, to the old station, the Gare d'Orleans. From that station the line has been prolonged along the bank of the river to the Quai d'Orsay, partly in open cut and partly in tunnel of the section shown in Fig. 7, the section between the two stations being operated by electricity on a third-rail. This latter section, a box-like tunnel built on the side of the high banks of the Seine with track level only about 2 ft. higher than mean water, had its outside wall penetrated with arched open-

FIG. 5. VIEW FROM RIGHT BANK OF SEINE, LOOKING ACROSS THE RIVER TOWARD THE EIFFEL TOWER, CHAMPS ELYSEES ON THE RIGHT.

(Sacks of sand placed by the Engineer Corps of the Army to reinforce quay walls.)

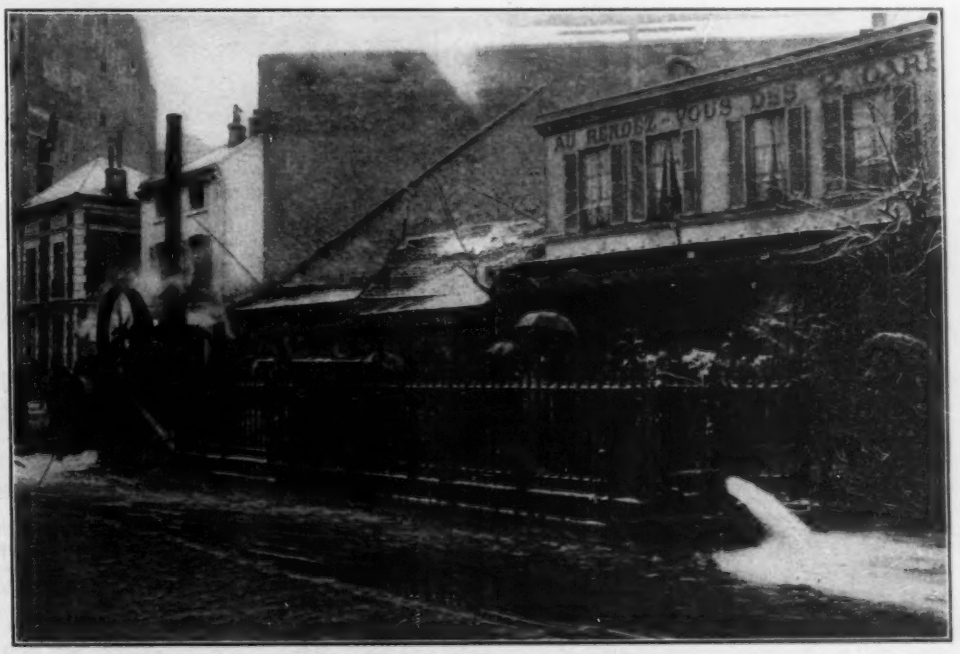


FIG. 6. PUMPING OUT A FLOODED SUBWAY.

ings to give light and air. The parapet elevation of these openings was +32.0 m., only about 5 m. above the mean water of the river, an elevation quite frequently passed in floods, as was shown in the table at the beginning of this article. This tunnel terminated in a large 15-track station of the same general design as the tunnel as far as elevations are concerned.

The rising waters soon percolated through the protecting banks of the open cut of the Orleans road and, covering the third rail, put the road out of commission. By Jan. 23, however, the river had reached Elevation +32 m. and overflowed into the tunnel, washing then freely down into the Gare de Quai d'Orsay, which was flooded far above the waiting rooms and ticket offices. This partial tunnel, then, formed a sort of parallel canal through which the rushing waters of the Seine flowed to the terminal station, there to spread over the surrounding streets, which might have been protected by the quay walls, had not the tunnel channel been open. Fig. 8 shows the river at about Elevation +31 m. outside of the arched openings into the Orleans tunnel.

SUBWAYS.—As shown in Fig. 2, Paris is one network of passenger subways. These lines are in two systems, the Compagnie du Chemin de fer Metropolitain, known as the Metropolitain and the Chemin de fer Nord-Sud, which is still under construction, though for the most part completed. Each of these lines crosses the Seine in tunnels and these tunnels were penetrated by the water or else the nearby stations were filled by the overflow so that great damage was done to the structures and traffic on the operating lines interrupted.

So far as can be ascertained, in no case did the water reach high enough on the shore to enter the stations of the Metropolitain, but beginning on Jan. 22 water began to penetrate the floors of its Bercy powerhouse, and, reaching the dynamos, cut off the current for a large part of the line. Soon after water entered the roofs and walls of the subways adjacent to the river and filled up the tracks to the height of the station platforms. The view in Fig. 9 is taken in the station St. Michel, on the Metropolitain, just

Fig. 8. View Outside the Paris-Orleans Tunnel Shown in Fig. 7.
(Water elevation about +31.0 m.)

opposite the Ile de la Cité. No very great structural damage has as yet appeared in the subway, but the pumping out was not completed at the last reports available, so the conditions of the masonry cannot be told just at present. In some places it is reported that the infiltration through the walls was so great as to cause the collapse of portions of the arch. Although no water entered the stations of the Metropolitain, at least in one section, the percolation was so free as to fill the tunnel up to its roof and to run out on the station entrances. Fig. 6 shows a pump at work emptying one of the subways. This work was kept up during the floods but with very little success.

The Nord-Sud railway is in course of construction and for that reason offered a fairer mark to the flood than did the Metropolitain. At the sections near the river the water soon overflowed into the stations or the open cuts

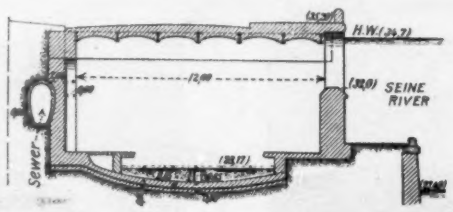


Fig. 7. Section Through the Tunnel of the Paris-Orleans R. R. Parallel to the River.
(Dimensions given in meters.)

where work was in progress, and from there filled the whole system up to the level of the floods of the river. On account of the unfinished state of the work the damage done on this line was much greater than on any other, not only to the subway structure proper, but also to the surrounding foundations, the soil under which was thoroughly saturated by the overflow from the tunnels.

In one place the Nord-Sud tunnel under the Seine served to carry a flood far back in the city (see Fig. 2). On the north or left bank of the Seine about the center of the city, the Nord-Sud subway goes under the Boulevard St. Germain to the river, under which it crosses in tunnel to the Place de la Concorde, and thence to a station at the Gare St. Lazare, about a mile distant from the river. The district between the St. Lazare station and the river is below Elevation +35 m. (the maximum flood elevation) but it was protected from the floods by good high quay walls on the right bank of the river. However, an excavation in the left bank on the Boulevard St. Germain was invaded by the water and the subway filled by the floods, which siphoned through the tunnel under the river and appeared at the St. Lazare Station a mile or more away, there to flood the entire surrounding district.

On Fig. 2 is shown the extent to which the various passenger subways were filled, and also the small detached areas throughout the city where minor inundations were caused by water backing up through pipes, sewers or subways.

FOUNDATION DANGERS.—In the damage to the foundations to the numerous buildings in the flooded section will probably be found the greatest effect of the inundation, although it is an effect that cannot be ascertained at present. The subsoil in Paris at the beginning of the present year seems to have been in a highly saturated state and the ground water elevation some distance above its ordinary level. Add to this the super-saturation brought about by the floods and the direct application of the flood water on the surface, and it will be seen that the foundations of all structures must necessarily be in a weakened condition except in the few cases where founded on solid rock. So far no collapses of any magnitude have been reported, although there are rumors that extensive underpinning will have to be made in some of the older government buildings.

DEFORESTATION.—It has been made plain in the first part of this article that the flood was due to continuous rains plus a heavy thaw of snow on ground already in a supersaturated state, and that the wooded state of the upper Seine had little to do with the trouble. However, in view of the present discussion on deforestation in its relation to floods, and particularly to many lay opinions that the recent inundation was due to deforestation, it may be well to quote the following extract from the article on the floods in "Le Genie Civil," Feb. 5, 1910, by M. A. Dumas:

> The influence of deforestation on floods, which is very important in countries with impermeable soil, is much less so in the basin of the Seine, for there it is always in the winter that the large floods occur; that is to say, when the leafless trees do not offer any opposition to the runoff of the rain. Reforesting evidently prevents the formation of ravines, but for that matter sodding will produce the same result.
>
> Belgrand, an authority on meteorology in general and on the Seine in particular, long studied the influence of deforestation on floods, and he estimated that what deforesting had occurred in the basin of the Seine had small influence upon the excessive stages of the water. "For a long time," he said, "I have thought, with many others, that forests prevented excessive floods and that the régime of the Seine on account of the deforesting had suffered profound modifications. But now, in spite of my previous opinion, from a long observation of the facts, I have come to a contrary opinion. Observations of long years have shown that the floods in the basin of the Morvan, a region covered with immense forests, were no less severe than those which occurred in the Auxois, a region entirely deforested."
>
> Without approving the deforestation which in the last few years has occurred in the region of the Morvan, it seems, however, that it would be hardly right to attribute to that deforestation an important influence on the floods which have recently afflicted Paris and its suburbs.

FIG. 9. THE ST. MICHEL STATION OF THE METROPOLITAIN SUBWAY FLOODED TO THE PLATFORM.

PREVENTIVE MEASURES. — Immediately after the subsidence of the flood (Feb. 9) the French government appointed a commission consisting mainly of government and private engineers to investigate the causes of floods, particularly on the Seine, and to report the best

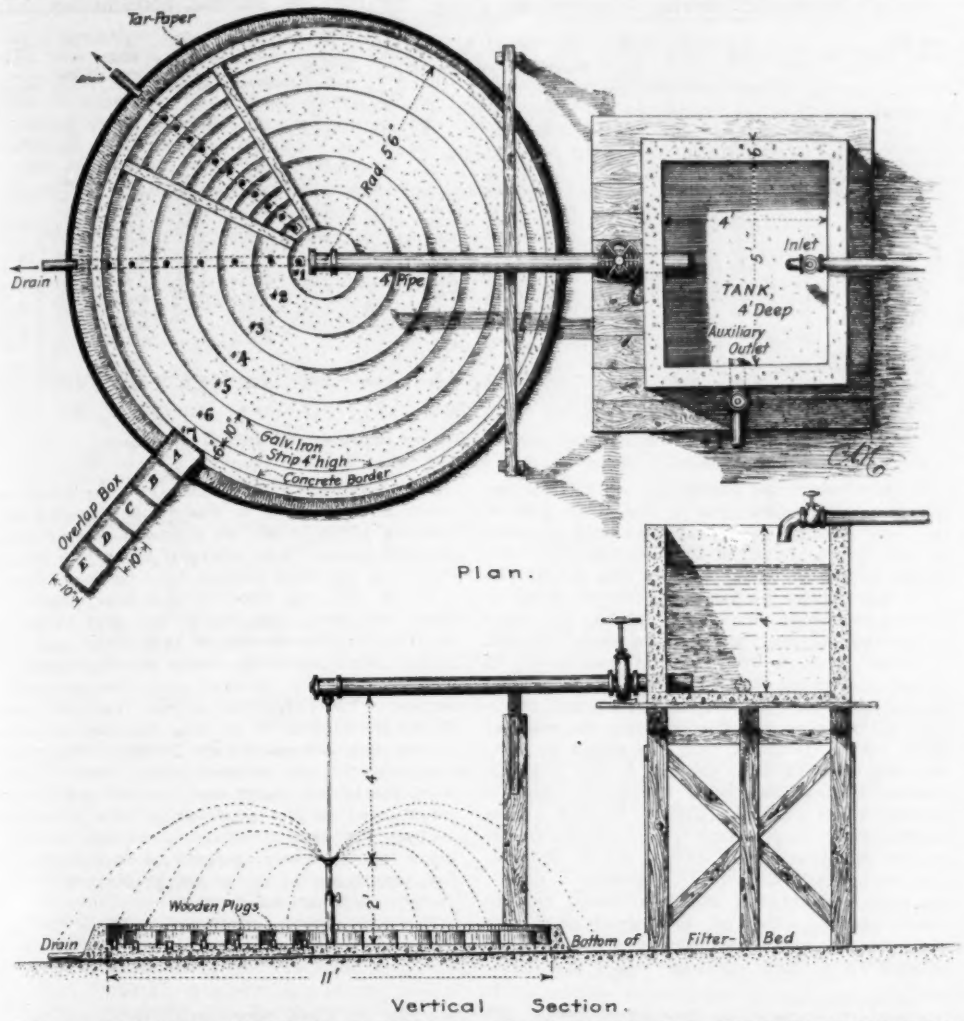


FIG. 1. PLAN AND SECTIONAL ELEVATION OF APPARATUS FOR TESTING DISTRIBUTION OF SEWAGE ON PERCOLATING FILTERS, MT. VERNON, N. Y.

means to prevent them, or if that be impossible or impracticable, to guard the city and its public services against them. Many suggestions as to the best means of reducing the floods, of course, have been suggested, but until this commission makes what promises to be a most exhaustive report, these suggestions are of small value.

Sewage Distribution Tests at Mount Vernon, N. Y.

By CHARLES A. HAMMOND,* M. Am. Soc. C. E.

Near the close of the year 1907, the city of Mount Vernon, N. Y., authorized Mr. John M. Farley, M. Am. Soc. C. E., as consulting engineer, and Mr. Geo. L. Robinson, Assoc. M. Am. Soc. C. E., as associate engineer, to present plans for a system of sewage disposal, under mandate of the State Supreme Court to discontinue sewage-pollution of Hutchinson River, the point of outfall being the lower part of the river, known as Eastchester Creek, a tidal estuary. The subsequent construction of the works was placed in the charge of the writer, as well as experiments with different forms of splash-cups. The design of percolating filters adopted for Mt. Vernon provided for gravity sprinklers, by which the sewage was to be permitted to fall in a solid, cylindrical stream from overhead nozzles (⅜ to ⅝-in. in diameter) a distance of about 4 ft., striking a splash-cup about 2 ft. above the surface of the filter. The object of the splash-cups is to break the applied sewage into a fine spray and distribute it over a circular wetted area.

Fig. 1 shows a plan and Fig. 2 a sectional elevation of the experimental apparatus used, the intention being to reproduce practically the same conditions under which the plant would be operated. The sloping concrete floor of an unfinished filter-bed was utilized as a site for the testing-plant, which consisted of a concrete tank, 4 × 5 ft. in plan and 4 ft. high, placed on an elevated platform to give the desired head. A 2-in. branch from the contractor's supply-pipe furnished the water used, and a 4-in. main outlet, controlled by a gate-valve, extended from the tank to the center of a circular bed of concrete, divided by galvanized-iron strips into concentric rings, each 10 ins. in width, except the outermost, which was 6 ins. wide. A sector of the concrete circle was still further sub-divided, as shown, and an extension-box (with 10-in. compartments) was used to receive the "overlap" spray, beyond the limits of the circle, which had a diameter of 11 ft. The galvanized-iron strips were set 2 ins. in the concrete, leaving the height of each ring 4½ ins. above the level of the concrete circle, which rested on tar-paper first laid on the filter-bed bottom, to facilitate subsequent removal. The rings were drained by 2-in. pipe, provided with 1-in. tees, closed by removable wooden plugs during the sprinkling flow and while measuring its depth. In the center of the circle a 1-in. pipe, telescoped in a 1¼-in. pipe, to secure adjustment of height, held the splash-cup to be tested. Each cup had a short central stem, fitting the pipe and bringing the center of the cup vertically under the brass nozzle, which was screwed into a 2-in. tee on the end of the 4-in. delivery pipe, as shown in Fig. 2.

In order to control the head, so that it could be kept constant at different heights, or made to fall continuously during a predetermined interval of time, a smaller outlet-pipe was placed in the tank, with a valve by which the depth of water could be regulated at pleasure. The adjustment of the valve on the inlet-pipe maintained the water-level at any desired height during the spraying discharge, or, if this discharge was to be made under a falling head, the small outlet-valve was opened to the extent required. The head on the splash-cup could thus be varied from 4 to 8 ft. The cup itself was usually placed 2 ft. above the wetted surface, that height having been found to give the best results.

The experiments were conducted to ascertain (1) The actual discharge of ⅜, 7/16, ½ and ⅝-in. cylindrical nozzles, under different fixed heads, and also under different falling heads. (2) The relative efficiency of the spray-distribution produced by splash-cups of different form and under different conditions of head, height above filter and quantity of discharge, and by nozzles of varying caliber.

In the attempt to ascertain the relative sprinkling efficiency, perfect distribution—that which would be the case if the entire area of the circle received an equal depth of liquid—was considered to have a numerical value of 100, and, although mathematical accuracy was not to be expected with the method employed, the relative results obtained sufficiently answered the purpose.

Fig. 3 is a diagrammatic representation of a portion of a filter-bed, showing the lines of dis-

FIG. 2. VIEW OF SEWAGE DISTRIBUTION TESTING APPARATUS, MT. VERNON, N. Y.

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tribution pipes and the location of the nozzles, each of which is over a circle of 5 ft. 5¾ ins. radius, the lines joining the centers forming nearly equilateral triangles, the circles being practically tangent to each other, except a slight longitudinal overlap (Fig. 4). The circle-diameters are thus nearly 11 ft.; but the best sprinkling results were obtained when the sprayed circle had a radius extending two or three feet beyond the circumference of the 11-ft. circles, causing overlaps, as shown by dotted lines in Fig.

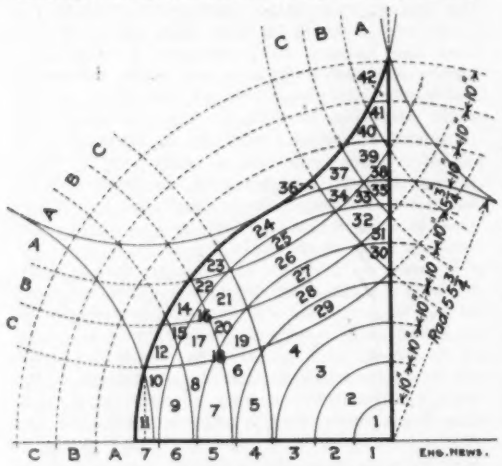


Fig. 4. Overlap Areas, Sewage Distribution Tests, Mt. Vernon, N. Y.

3. It will be noted that the area tributary to each nozzle consists of the full circle beneath it and two cusps, the imaginary boundaries of which are shown by the full lines in Fig. 3. The quadrant of a circle and one-half of a cusp-area, therefore, together constitute one-fourth of the area served by each nozzle, as shown in Fig. 4, in which the (experimental) interior rings are designated by the numerals 1 to 7, and the overlap rings by the letters A, B, C.

TABLE I.—OBSERVED DEPTHS IN CONCENTRIC RINGS. DEVICE FOR TESTING DISTRIBUTION OF SEWAGE.

Test No.	6	11	13	17	18	19	24	29	43	46	47	49	52
1909. Date	6/16	6/22	7/9	7/12	7/13	7/13	7/22	8/4	7/28	8/10	8/13	8/18	8/18
Cup	Yonkers,	Schodde,	Robinson	Wilkie, rimless	Wilkie, rolled edge	Wilkie, rimless	Robinson	Wilkie, rolled edge	Schodde,	Schodde,	Wilkie flat rim	Wilkie round rim	round rim
Cup height, feet	2	2	2	2	2	2	2	2	2	2	2	2	2
Size of nozzle, ins.	¼	5/16	7/16	7/16	7/16	5/16	1/16	7/16	1/16	5/16	¼	7/16	1/2
Constant head ft.	....	....	....	....	....	7	7	....	7	7	....	8	8
Falling head, ft.	8 to 4	8 to 4	8 to 4	8 to 4	7-7 to 6-1	....	....	8 to 5¼	....	....	8 to 4	....	....
Time in minutes	40	40	30	40	35	39	..	30	26	23	40	38	30
Depth Ring No. 1	4.40	2.37	4.40	1.12	3.00	0.40	4.50	2.75	4.50	4.25	2.90	2.50	3.80
2	1.30	0.25	2.40	1.75	3.12	0.40	1.75	3.25	1.75	2.50	3.50	4.00	3.50
3	2.65	1.12	2.12	2.75	3.90	0.90	2.00	3.25	1.75	3.00	4.00	4.30	3.90
4	2.65	1.75	3.12	3.35	3.40	2.62	2.75	3.50	2.50	2.25	4.00	4.00	4.00
5	3.40	2.62	2.40	3.35	3.15	3.87	3.25	3.50	2.25	2.50	3.70	4.00	4.00
6	3.40	3.25	1.12	2.75	3.15	3.50	3.62	3.00	3.50	1.25	3.50	4.00	3.90
7	3.15	3.50	1.12	1.25	2.62	3.12	3.25	2.25	2.75	1.00	3.20	3.80	3.50
A	1.40	1.37	0.63	0.40	0.85	2.62	1.50	1.12	1.50	0.25	1.20	2.20	1.70
B	0.65	0.75	0.25	0.12	0.35	1.12	0.25	0.50	0.75	....	0.60	1.20	1.00
C	0.05	0.12	....	....	0.25	0.12	0.05	0.25	0.25	....	0.30	0.50	0.50
D	....	....	....	....	....	....	....	....	0.05	....	0.10	....	0.30
*Average depth in inches, including overlap	3.39	3.00	2.12	2.58	3.44	3.81	3.38	3.49	3.32	1.91	4.13	4.99	4.80
*Percentage of perfect distribution	78.9	63.6	74.0	71.0	92.2	60.0	77.3	91.5	71.4	63.0	91.1	87.0	88.6

*These final averages and percentages were entered after the subsequent calculations were made.

In calculating the percentage of perfect distribution, the entire area of the circle and of the two external cusps is taken into account, as well as the effect of the overlap. The observed depths of water in each ring at the end of a test applied to the overlap-areas (Fig. 4), gives a series of corrections which are used in determining the final average depth on each ring-area and on the external cusp-area, all of which enter into the final result. The observed depths, as thus corrected for each ring, represent the average distribution upon the annular space within its limits, and if a profile be plotted (Fig. 5) with these average depths and successive widths shown as horizontal lines a curved line may be drawn through these horizontals, representing an approximately correct resultant profile of the actual distribution along any radial line. In such a profile, the distances between abscissas should be proportioned to the relative area which each ring bears to the whole area of the wetted surface covered by a single spraying nozzle and cup.

For representing, approximately, the effect of overlap, a plan (Fig. 4) was drawn, showing the crossing of the rings on a quadrant (including external area). The sectional areas into which each ring was thus divided were numbered from 1 to 42, and the area of each was measured. Each concentric ring, except the first three, is seen to comprise several of such areas, and the proper depth on each would be the combined depths of all the overlaps upon that particular section. The proportion of each fractional area to the whole area of the ring was used in computing the average depth for each ring, and, similarly, for the external (cusp) area. Likewise, the proportion of each interior ring or external area to the whole-circle area (cusp included) was used in obtaining the final average depth, as the corrected result of each particular test, expressed as a certain percentage of the perfect distribution.

The illustrative examples here given are selected from about seventy-five different tests. The data obtained from observation and the re-

TABLE II.—ILLUSTRATING METHOD EMPLOYED IN CORRECTING DEPTHS OF SEWAGE IN APPARATUS DESIGNED TO SHOW EFFICIENCY OF DISTRIBUTION, MT. VERNON TESTS.

Ring No.	Section No.	Area in sq. ins.	Area per cent.	Overlap.	Test No. 6.	Test No. 11.	Test No. 13.	Test No. 17.	Test No. 18.	Test No. 19.	Test No. 24.	Test No. 29.	Test No. 43.	Test No. 46.	Test No. 47.	Test No. 49.	Test No. 52.
1	1	314	100	.....	4.40	2.37	4.40	1.12	3.00	0.40	4.50	2.75	4.50	4.25	2.90	2.50	3.80
2	2	942	100	.....	1.30	0.25	2.40	1.75	3.12	0.40	1.75	3.25	1.75	2.50	3.50	4.00	3.50
3	3	1,571	100	.....	2.65	1.12	2.12	2.75	3.90	0.90	2.00	3.25	1.75	3.00	4.00	4.30	3.90
4	4	865	40	d+d	2.65	1.75	3.12	3.37	3.40	2.62	2.75	3.50	2.50	2.25	4.30	4.00	4.60
	5	670	30	c+d	2.70	1.87	3.12	3.37	3.65	2.75	2.80	3.75	2.75	2.25	4.40	4.50	4.80
	20	664	30	c+d	2.70	1.87	3.12	3.37	3.65	2.75	2.80	3.75	2.75	2.25	4.40	4.50	4.80
		2,199	100		2.67	1.82	3.12	3.37	3.56	2.70	2.80	3.65	2.65	2.25	4.36	4.30	4.72
5	6	280	9	c	3.46	2.75	2.40	3.37	3.40	4.00	3.30	3.75	2.50	2.50	4.00	4.50	4.50
	7	595	21	b	4.05	3.37	2.65	3.50	3.50	5.00	3.50	4.00	3.00	2.50	4.30	5.20	5.00
	18	25	1	b+c	4.10	3.50	2.65	3.50	3.75	5.12	3.56	4.25	3.25	2.50	4.60	5.70	5.50
	19	395	14	c+c	3.50	2.87	2.40	3.37	3.65	4.12	3.37	4.00	2.75	2.50	4.30	5.00	5.00
	27	330	12	b	4.05	3.37	2.65	3.50	3.50	5.00	3.50	4.00	3.00	2.50	4.30	5.20	5.00
	28	1,100	39	c+d+d	3.46	2.75	2.40	3.37	3.40	4.00	3.30	3.75	2.60	2.50	4.20	4.50	5.10
	30	122	4	c+c	3.50	2.87	2.40	3.37	3.65	4.12	3.37	4.00	2.75	2.50	4.30	5.00	5.00
		2,527	100		3.66	2.98	2.48	3.40	3.44	4.35	3.36	3.88	2.76	2.50	4.24	4.83	5.00
6	8	250	7	b	4.05	4.00	1.37	2.87	3.50	4.62	3.87	3.50	4.25	1.25	4.10	5.20	4.90
	9	515	15	a	4.80	4.62	1.75	3.12	4.00	6.12	5.12	4.12	5.00	1.50	4.70	6.20	5.60
	13	50	1½	a+c	4.85	4.75	1.75	3.12	4.25	6.25	5.20	4.40	5.25	1.50	5.00	6.70	5.10
	16	50	1½	b+b	4.70	4.75	1.62	3.00	3.85	5.75	4.12	4.00	5.00	1.25	4.70	6.40	5.90
	17	420	12	b+c	4.10	4.12	1.37	2.87	3.75	4.75	3.92	3.75	4.50	1.25	4.40	5.70	5.40
	20	310	9	c+c	3.50	3.50	1.12	2.75	3.65	3.75	3.75	3.50	4.00	1.25	4.10	5.00	4.90
	21	275	8	b+c	4.10	4.12	1.37	2.87	3.75	4.75	3.92	3.75	4.50	1.25	4.40	5.70	5.40
	25	206	6	a	4.80	4.62	1.75	3.12	4.00	6.12	5.12	4.12	5.00	1.50	4.70	6.20	5.60
	26	867	25	b+d+d	4.05	4.00	1.37	2.87	3.50	4.62	3.87	3.50	4.40	1.25	4.30	5.20	5.30
	31	118	3½	c+c	3.50	3.50	1.12	2.75	3.65	3.75	3.75	3.50	4.00	1.25	4.10	5.00	4.90
	32	395	11½	b+c	4.10	4.12	1.37	2.87	3.75	4.75	3.92	3.75	5.00	1.25	4.40	5.70	5.40
		3,456	100		3.95	4.13	1.43	2.91	3.72	4.91	4.16	3.71	4.52	1.31	4.39	5.58	5.37
7	10	140	6	a	4.50	4.87	1.75	1.62	3.25	5.75	4.75	3.40	4.25	1.25	4.40	6.00	5.20
	11	60	2½	+7	6.30	7.00	2.25	2.50	5.25	6.25	6.50	4.50	5.50	2.00	6.40	7.60	7.00
	12	264	11	a+c	4.60	5.00	1.75	1.62	3.75	5.87	4.80	3.60	4.50	1.25	4.70	6.50	5.70
	14	245	10	b+b	4.45	5.00	1.63	1.50	3.40	5.37	3.75	3.25	4.25	1.00	4.40	6.20	5.50
	15	57	3½	b+c	3.85	4.37	1.37	1.37	3.25	4.37	3.56	3.00	3.75	1.00	4.10	5.50	5.00
	22	132	3½	b+c	3.85	4.37	1.37	1.37	3.25	4.37	3.56	3.00	3.75	1.00	4.10	5.50	5.00
	23	330	14	a+c	4.60	5.00	1.75	1.62	3.75	5.87	4.80	3.60	4.50	1.25	4.70	6.50	5.70
	24	710	30	a+d+d	4.50	4.87	1.75	1.62	3.25	5.75	4.75	3.40	4.35	1.25	4.60	6.00	5.80
	33	159	6½	b+c	3.85	4.37	1.37	1.37	3.25	4.37	3.56	3.00	3.75	1.00	4.10	5.50	5.00
	34	188	8	a+c	4.60	5.00	1.75	1.62	3.75	5.87	4.80	3.60	4.50	1.25	4.70	6.50	5.70
	35	90	4	b+c	3.85	4.37	1.37	1.37	3.25	4.37	3.56	3.00	3.75	1.00	4.10	5.50	5.00
		2,375	100		4.50	4.90	1.68	1.59	3.50	5.51	4.48	3.40	4.38	1.20	4.55	6.20	5.58
A	36	50	7	a+a	2.80	2.75	1.25	0.75	1.70	5.25	3.00	2.25	3.00	0.50	2.40	4.40	3.40
	37	330	47	a+a+c	2.85	2.87	1.25	0.75	2.00	5.37	3.06	2.50	3.25	0.50	2.70	4.90	3.90
	38	110	16	a+b+b	2.70	2.87	1.13	0.62	1.62	4.87	2.00	2.12	3.00	0.25	2.40	4.60	3.70
	39	210	30	a+a+b	3.45	3.50	1.50	0.87	2.12	6.37	3.25	2.75	3.75	0.50	3.00	5.60	4.40
		700	100		3.00	3.03	1.30	0.77	1.94	5.58	2.94	2.50	3.34	0.46	2.72	5.03	3.98
B	40	190	60	a+b+b	2.70	2.87	1.13	0.62	1.62	4.87	2.00	2.12	3.00	0.25	2.40	4.60	3.70
	41	120	40	a+a+b	3.45	3.50	1.50	0.87	2.12	6.37	3.25	2.75	3.75	0.50	3.00	5.60	4.40
		310	100		3.00	3.12	1.30	0.72	1.82	5.48	2.49	2.37	3.30	0.33	2.64	5.00	3.98
C	42	80	100	a+a+c	2.85	2.87	1.25	0.75	2.00	3.61	3.06	2.50	3.25	0.50	2.70	4.90	3.70

sulting calculations are presented in tabular form. The fundamental data—measured depths, etc.—are first recorded in Table No. 1.

Table II. illustrates the method of calculating the average depth in each ring as corrected by the addition of the overlap depths. In column 1 is the number of each ring represented in Fig. 4, and in column 2 are the numbers of the sectional areas which constitute the different rings. Column 3 gives the area of each section and the total area of each ring. In column 4 is stated what percentage each sectional area is of the total ring-area. In column 5 the small letters (corresponding to the letters A, B, C of the overlap rings) refer to the overlap-depths which are added to the observed ring-depth for each section. The remaining columns, numbered for each test, give the corrected depths on each section, due to the overlap additions. The average depth on each ring, comprising the original measured depth plus the different overlaps, as noted in each column opposite the total ring-area of the wetted surface, is obtained by multiplying the corrected depth on each section by its percentage of area and dividing the sum of the products by 100.

The final determination of distribution efficiency was arrived at by the method indicated in Table III., the two tests therein included being sufficient for illustration. The average depth shown at the foot of column 2 is found by multiplying each corrected depth (column 2) by its corresponding relative area (col. 5), and dividing the sum of the products by the footing of column 5.

The models of splash-cups first employed in these tests conformed to those found to give the best results in the well-known experiments of Professors Winslow and Phelps at the Massachusetts Institute of Technology, and these gave efficiencies varying from 56% (Test 15) and 65.6% (Test 14) to 78.9% (Test 6). It was discovered that the addition of a rim, flat or rolled, around the edge of the cup increased the percentage of efficiency to 87% (Test 49), 91.5% (Test 29) and 92.2% (Test 18). It is possible that the rim may offer sufficient resistance, or induce a sufficient amount of divergency, to cause some of the under laminae of the splash to either lose velocity, or take a quicker curve downward, and so wet the first three or four rings of the circle more evenly than was the case with the rimless cups.

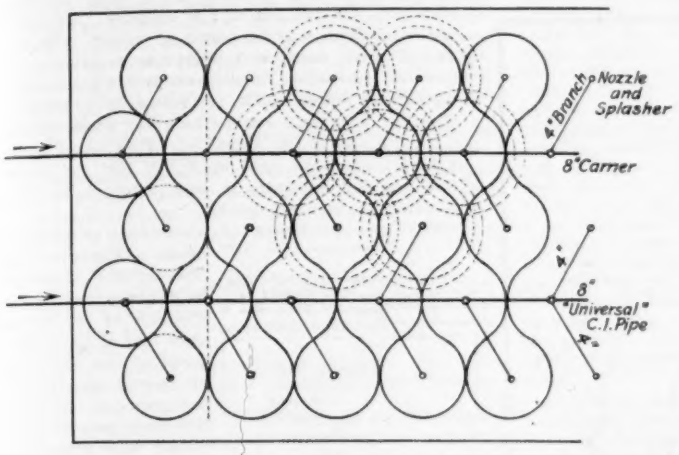


FIG. 3. LAY-OUT OF PERCOLATING SEWAGE FILTERS, MT. VERNON, N. Y.

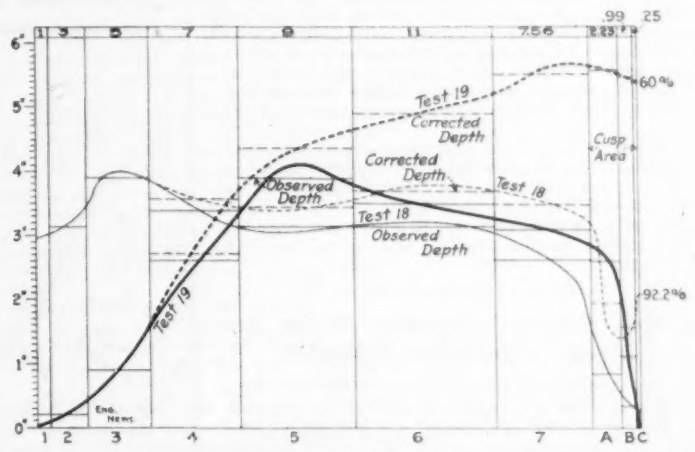


FIG. 5. PROFILE SHOWING EFFECT OF OVERLAP AREAS IN SEWAGE DISTRIBUTION TESTS, MT. VERNON, N. Y.
(A 1-in. nozzle was in use when this view was taken.)

TABLE III.—EFFICIENCY OF SEWAGE DISTRIBUTION, MT. VERNON TESTS.

	Ring No.	Corrected average depth, in ins.	Variation from average depth on whole area.	Percentage of variation.	Relative area of rings.	Products, Col. 4 × Col. 5.
Column	1	2	3	4	5	6
Test No. 18	1	3.00	—0.44	12.8	1	12.8
	2	3.12	—0.32	9.3	3	27.9
	3	3.90	+0.46	13.4	5	67.0
	4	3.56	+0.12	2.5	7	17.5
	5	3.44	0.0	0	9	0
	6	3.72	+0.28	8.1	11	89.1
	7	3.50	+0.06	0.2	7.56	1.5
	A	1.94	—1.50	43.6	2.23	97.2
	B	1.82	—1.62	47.1	0.99	47.0
	C	2.00	—1.44	41.9	0.25	10.2
Average		3.44		Total.	47.03	370.2
		Efficiency: 100 — 7.8 = 92.2%.				7.8
Test No. 19	1	0.40	—3.41	89.3	1	89.3
	2	0.40	—3.41	89.3	3	267.9
	3	0.90	—2.91	76.4	5	382.0
	4	2.70	—1.11	29.6	7	207.2
	5	4.35	+0.54	14.2	9	127.8
	6	4.91	+1.10	28.9	11	317.9
	7	5.51	+1.70	44.6	7.56	337.2
	A	5.58	+1.77	46.5	2.23	103.7
	B	5.48	+1.67	43.8	0.99	43.4
	C	5.40	+1.59	41.7	0.25	10.4
Average		3.81		Total.	47.03	1,886.8
		Efficiency: 100 — 40 = 60%.				40

The Strength of Treated Timber.*

The average of the results with Douglas fir tested at the Sacramento shops of the Southern Pacific Ry. and at the University of California indicates a decrease of the modulus of elasticity of some 10 or 15% for the creosoted timber, as compared with untreated timber; and a decrease of some 30% in the outer stress at elastic limit and at failure.

This creosoted timber, however, was treated by the boiling process, and the records of treatment were destroyed in the San Francisco fire of 1906, so that the details are not available. It is probable that the heating by the boiling process may have been responsible for the weakening of the timber, or it may be that the characteristics of the Douglas fir timber are such that it will be weakened by treatment. It is to be noted that sticks 4 × 6 ins. in cross-section were cut from the interior of the large sticks where the creosote had not penetrated, and that these showed about half the strength of untreated sticks of similar size. It is possible that the temperatures formerly used were in excess of those of present practice. Further tests will be necessary before this question can be definitely determined. Such tests are under way at Seattle, Wash., under direction of the Forest Service.

Tests of long leaf yellow pine show little if any reduction in outer fiber stress at failure for creosoted bridge stringers as compared with the natural wood. These tests cover ten beams of treated and ten untreated in each case, representing very carefully selected material, well matched, and with the full history of treatment, etc., known.

These tests showed that the difference between the strength of the top end and the bottom end of the 32-ft. stringer may be anywhere from 8 to 20%, and this difference between the butt and top should, therefore, be considered in drawing conclusions from the tests.

The tests of loblolly pine at Purdue University in connection with the tests of long leaf yellow pine mentioned above showed a loss in strength of the loblolly pine in flexure of about 16%, and in compression perpendicular to the grain about 29%.

Tests by Prof. Talbot on Loblolly pine beams, show a reduction of 44% in elastic limit and 30% at maximum load, but in other tests a greater strength when treated is shown. The latter result is corroborated by the results of tests of small test beams taken from the uninjured portion of the beams. In tests in which the alternate sticks were creosoted, the treated timber gave 17% less strength at elastic limit and 22% less strength at maximum load than the untreated timber. The strength of the treated shear blocks was 11% less than that of the untreated blocks.

In unpublished tests which were made some time ago at the University of Illinois, on oak and gum ties (the half length of each tie being treated and the other half being untreated) the modulus of rupture, elastic limit, and shearing strength are stated by Prof. Talbot to have been from 5 to 10% less than the values of the untreated ties.

The indications are that creosoting has little effect on the strength of Douglas fir or Wisconsin white pine in tension or end compression; but does weaken it some 20 to 25% in shear. Burnettizing appears to weaken the timber, but the Burnettized specimens were not so dry as the untreated. It may be noted that the cellulose is soluble in a 40% solution of zinc chloride.

The conclusions to be reached from Forest Service Circular 309, "Experiments on the Strength of Treated Timber," are fairly well based, and are as follows:

Treatment with zinc chloride at a temperature of about 250° F. renders the timber brittle. It is possible this may be on account of free acid in the solution, but this question will require further investigation before it can be determined. Creosote itself is largely inert, and has its chief influence in modifying the transmission of moisture in or out of the wood. Excessive steam pressures are detrimental to the timber; anything over 4 hours at 30 lbs. or 6 hours at 20 lbs. exceeding the safe limits.

In Dr. Hatt's fourth progress report of tests of treated ties the tests showed very little diminution in strength in rail bearing for either creosoted or burnettized red oak or creosoted loblolly pine ties as compared with the untreated timber. The lateral and pulling resistance of the spikes did not appear to be affected much, if at all, by treatment of the timber, except in the case of crude oil. The crude oil was unusually viscous and a temperature of 210° F. was used. The extremes of atmospheric temperature are found to have an appreciable effect on the strength of wood, especially when green. The warm timber is from 9 to 17% weaker than the very cold timber.

In many of the tests the records of treatment are not available, and the cause of the apparent diminution of strength on account of treatment cannot be determined without further research. Experience has demonstrated, however, that excessive heating greatly reduces the strength of timber.

The committee desire to call attention to the necessary data that should accompany any report on the effect of treatment upon the strength of wood. In many cases the results are entirely accidental, and the variation in strength introduced by the elements other than the treatment will entirely mask the latter. The reports should be examined with reference to the following elements at least: description of wood with reference to heart, sap and openness of grain; condition of seasoning; details of treatment, including analysis of preservative and steam pressure (if any); temperature of oil or preservative; length of time between treatment and test, and exposure during this time; origin of test pieces to eliminate difference of strength between butt and top of long sticks.

Again, in quoting the conclusions, the particular exhibition of strength should be considered. For instance, very wet wood, and probably wood heavily dosed with creosote, will show greater weakness under side compression than under flexure or end compression. Then, too, it must be clearly distinguished whether small pieces of timber are treated or large pieces, because the artificial seasoning under the high temperatures of the cylinder will introduce internal strains that result in serious checks, when large timbers are treated. This weakness is more likely to appear in tests of the material under shear or in ruptures of large beams under longitudinal shear.

*From the report of the Committee on Wood Preservation, presented at the annual meeting of the American Railway Engineering and Maintenance of Way Association, held at Chicago, March 15-17. The report was accompanied by tables and diagrams of numerous tests.

The data which have been obtained on this subject appear to support the following conclusions: (A) With reference to small material, such as ties: (1) high steaming will diminish the strength rapidly; (2) treating with strong solution of zinc chloride will render the timber brittle, perhaps because of free acid in the solution; (3) creosote is inert; (4) seasoned timber treated with light doses of creosote is as strong as the original timber.

(B) With reference to large bridge material: (1) the use of high steam pressures of 40 to 50 lbs. is attended with considerable loss of strength; (2) the thermal condition of the treatment introduces internal strains that result in internal checks, which in turn weakens the timber to shearing stresses; (3) heavily creosoted material is weak in compression at right angles to the grain.

(C) Treatment with crude petroleum may render wood soft and weak, at least temporarily; it is to be determined whether this is the effect of the process or of the preservative.

These conclusions should not be accepted as final, but are based on the best available data at this time, and are believed to be reliable.

Electric Power Development on the Los Angeles Water-Supply Aqueduct.

The construction of the Los Angeles Aqueduct from the Sierra Nevada Mountains to the San Fernando Valley, a distance of 230 miles, was primarily undertaken to furnish an adequate domestic water-supply for Los Angeles and adjoining towns, but electric-power development from this source has always been one of the most attractive financial phases of the project. In June, 1907, a bond issue of $23,000,000 was voted for the building of the aqueduct, but electric-power development had no part in the financial estimates. This was due to the fact that the city at this time was bonding itself to the limit of its bonded indebtedness for water development alone. It was also the opinion that the power, stated in the report of John R. Freeman, Frederic P. Stearns and J. D. Schuyler, comprising the first Board of Consulting Engineers,* to be 93,000 HP. measured at the point of delivery in hours of greatest demand, should not be developed until the completion of the aqueduct had been successfully accomplished.

However, Los Angeles City finances now make it possible to issue more bonds; approximately $400,000 can be saved in aqueduct construction through San Francisquito Canyon if power development is undertaken at the same time, and the city is anxious to have the project on a paying basis as soon as it is practicable.

In December, 1909, the City Council appropriated $20,000 for preliminary investigation of the power output of the aqueduct, and a Board of Consulting Electrical Engineers, consisting of Prof. W. F. Durand, M. Am. Soc. M. E., head of the Mechanical Engineering Department of Leland Stanford University; Prof. H. J. Ryan, M. Am. Inst. E. E., head of the Electrical Engineering Department of the same university, and Mr. O. H. Ensign, M. Am. Inst. E. E., Chief Electrical Engineer of the United States Reclamation Service, were selected to investigate the conditions.

This board on Feb. 12 filed a preliminary report (made public March 4) that the public might be given some idea of the power possibilities of the project, and a bond issue for $3,500,000 will be voted upon April 19 for the development of a part of the electrical energy spoken of in the report. As there appears to be practically no opposition to the bonds, it is expected and planned to have one or more of the power-houses ready for operation upon the completion of the aqueduct, now estimated for December, 1912, instead of a year later, as was given in the first estimates.

The aqueduct project is shown in Fig. 1, reproduced from Engineering News, Jan. 24, 1907. The aqueduct proper was to have a capacity to deliver 400 cu. ft. per sec. A canal starts about 12 miles above the town of Independence with a carrying capacity of 700 sec.-ft., but increasing as the side streams are crossed. From Cottonwood Creek to the main reservoir at Haiwee Meadows the canal carrying capacity is 900 sec.-ft. This large capacity has been employed in order to gather up flood water for storage, in varying amounts, for discharge into the aqueduct at the normal steady flow of 400 sec.-ft.

The first Board of Consulting Engineers (see report reprinted in Engineering News, Jan. 24, 1907) found three localities along the line of the aqueduct where a surplus fall could be utilized for the generation of power. What this board considered the most important location was about 45 miles from Los Angeles and near the outlet of a long tunnel at Elizabeth Lake. Here they found a head of nearly 1,500 ft. available. It was reported that this could be most advantageously developed by two stations working under heads of 1,060 and 415 ft. respectively. The third site was found not far below the end of the aqueduct in the San Fernando valley where a net fall of 215 ft. would exist. The fourth site was located near Little Lake, about 150 miles from Los Angeles and some 15 miles below the Haiwee reservoir. A net fall of 2[illegible] ft. could be made available here.

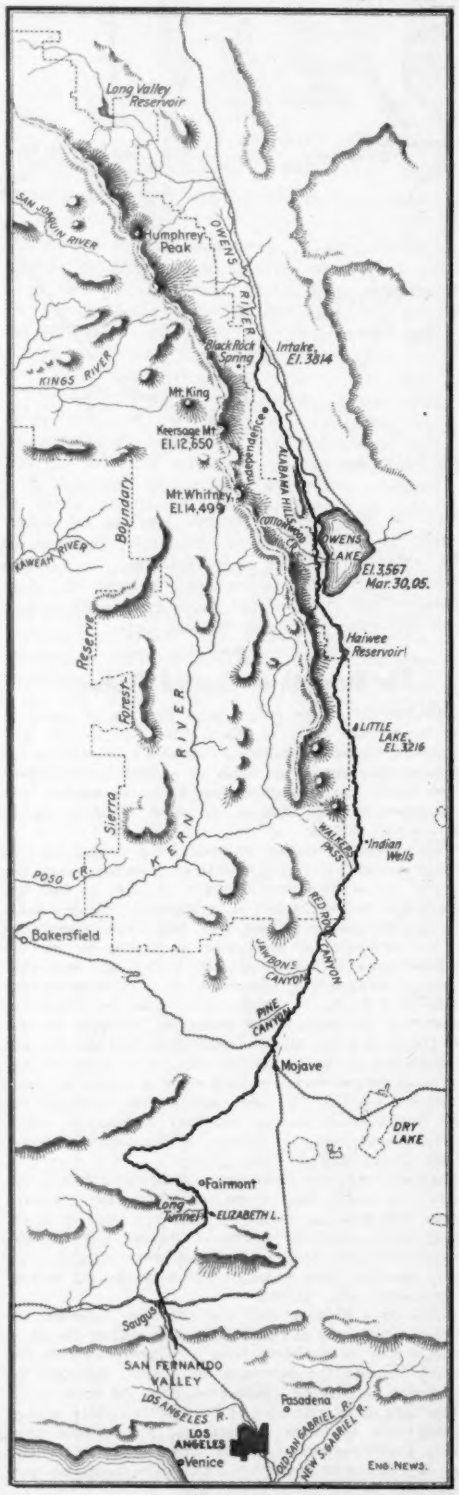


Fig. 1. Map Showing Location of Proposed 226-Mile Aqueduct for the Municipal Water Supply of Los Angeles, Cal.
(Reproduced from Engineering News, Jan. 24, 1907.)

This first Commission reported that, with [illegible] average delivery of 400 sec.-ft. per day, a total of 49,000 HP. or 36,600 KW. could be continuously transmitted to Los Angeles. An alternative scheme was proposed by which, with the use of small dams and equalizing reservoirs below the two more important power-houses, the water for power could be drawn in a variable flow but with uniform delivery for water-supply from the end of the aqueduct. This would allow a maximum peak load of 93,000 HP., or 69,[illegible] KW., to accommodate a load factor on the Los Angeles substation of 40%.

Single-Ckt. 30,000-V. Line
Two -Ckt. 80,000-V. "
Three-Ckt. 80,000-V. "
Four -Ckt. 80,000-V. "
Division Creek P.H. 600 KW. Continuous Capacity
40 Miles
Cottonwood P.H. No. 2 2500 KW. Con. Cap.
Cottonwood P.H. No. 1 1500 KW. Con. Cap.
23 Miles
Haiwee P.H. 4500 KW. Con. Cap.
39 Miles
Freeman Switching Sta.
41 Miles
Mojave Switching Station
36 Miles
San Francisquito P.H. No. 1 51,750 KW. Peak Cap.
San Francisquito P.H. No. 2. 32,000 KW. Peak Cap.
16 Miles
Fernando Power House and Switching Sta. 7250 KW. Continuous Cap.
24 Miles
Los Angeles Sub Sta. 90,000 KW. Peak Cap.

Fig. 2. Diagram of the Los Angeles Aqueduct Power-Generation and Transmission System.

The present Board of Consulting Engineers made a trip over the line of the aqueduct in January for the inspection of the power sites and of those features of the aqueduct of special importance to problems of water development. The Board has access, of course, to the aqueduct designs and to data and information secured by the Power Bureau. As the result of such a preliminary study, the Board reported several findings which are reprinted below.

FEASIBILITY.—The general plan of the development of electric power along the line of the aqueduct and its transmission to Los Angeles and vicinity is, in our opinion, a thoroughly practicable scheme, involving no engineering problems which should not permit of successful solution, and promising a reliable source of power which should find a ready market at prices advantageous to the city.

CAPACITY.—Taking, as points of departure, the aqueduct surveys for amounts of fall and the reports of stream flow and capacity on which the general aqueduct design is based, we find that the total amount of power which can be delivered in the vicinity of Los Angeles and ready for sale at step-down voltage is approximately 1,152,000 KW.-hrs. per day, corresponding to a uniform delivery of 48,000 KW. or 64,000 HP. for 24 hrs. or to a maximum delivery of 90,000 KW. or 120,000 HP. on a load curve of form corresponding to the average conditions in and about Los Angeles at the present time and of which the average load is 53% of the maximum. The accompanying diagram (Fig. 3) shows the characteristics of this load curve. It will be noted that this estimate of power is approximately 30% in excess of the estimate made by your first Board of Consulting Engineers for the general aqueduct project. To explain this difference the two following points may be noted:

(a) The power available at Cottonwood and Division Creeks, amounting to some 4,500 KW., was not contemplated or included in these earlier estimates.

(b) Final surveys for location with special reference

*The report of the Board of Consulting Engineers was reprinted in Engineering News, Jan. 24, 1907.

to power development have permitted of more advantageous locations of power sites, thus securing higher heads and a corresponding increase in the power available, without increase of cost of aqueduct construction.

COST OF DEVELOPMENT AND TRANSMISSION.—Our estimate of the installation costs for the development and transmission of this power ready for sale at step-down voltage at Los Angeles, based on a peak load capacity of 90,000 KW., or 120,000 HP., is $80 per KW. or $60 per HP.

This estimate of cost is less, to very marked degree, than the average cost of hydraulic power development and installation elsewhere on the Pacific coast and under generally similar physical conditions and surroundings. Among other causes for such difference, the following special conditions which affect the present development may be mentioned:

(a) In the case of the present development the primary diversion works are a part of the aqueduct project and, furthermore, the water is carried along the aqueduct line in close proximity to the power sites. Under these circumstances the cost of hydraulic development for power in conjunction with an aqueduct should naturally be somewhat less than for the development of a water-power independently.

(b) The principal power sites are in relatively close proximity to the City of Los Angeles and are relatively accessible for the transportation and installation of equipment.

(c) Our general examination of the power sites indicates no unusually severe or unforseen conditions for engineering construction.

(d) The early study of the problems of power development and transmission will secure time for a complete

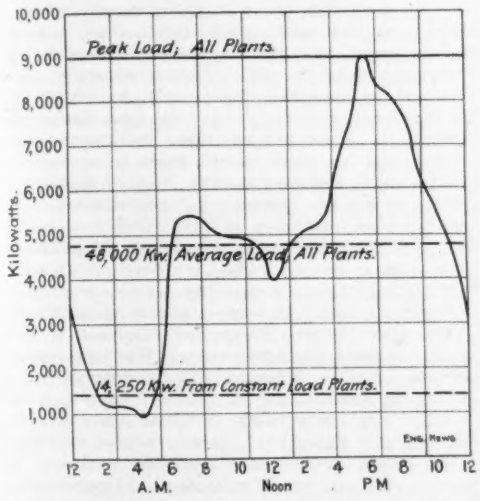


Fig. 3. Estimated Daily Load Diagram of Los Angeles, Cal.

Max. load, 90,000 KW.
Av. load, 48,000 KW.
Max. load above constant power output, 75,750 KW.
Av. load above constant power output, 33,750 KW.
Load factor (total), 53%. Load factor (above constant power), 44.5%.

investigation of the actual conditions at the various sites, and for the careful preparation of complete plans in advance of undertaking the work of actual construction.

(e) The work of hydraulic development will profit by the experience gained in like work on the main aqueduct, and by the efficient organization which has been developed in the course of this project.

In connection with this estimate of cost, it should, at the same time, be noted that we have included therein all work directly required by or related to the projects of power development. In particular all extra charges for diverting water from the natural aqueduct line and handling it along a power line have been charged to power development the same as in the case of diversion from the course of a natural stream for power purposes. In brief in the distribution of charges between the aqueduct and power projects, the former is charged only with such features as should be directly necessary for passing the water as an aqueduct.

CHARACTERISTICS OF PROPOSED PLAN OF DEVELOPMENT.—Briefly, the plan of development as proposed by your Electrical Engineer embodies the following leading features:

(a) It is assumed that, under usual conditions, the average aqueduct flow per day will be at the rate of 400 cu. ft. per sec., and that this flow must be maintained or at least permitted, whether power is developed or not.

(b) With this steady flow the capacity of the power sites at San Fernando and at the Haiwee Dam together with those at the Cottonwood and Division Creek feeders with average stream flow of 20 sec.-ft. and 8 sec.-ft. respectively, will provide for the steady development of some 14,000 KW. and which is expected to represent under full development, substantially the minimum demand occurring in the early morning hours as indicated on the accompanying load curve.

(c) Superimposed upon this uniform output of 14,000 KW. sustained by these steady-flow plants, the amount of power required to accommodate the variable demand throughout the day, as indicated by the load curve above referred to, must vary from nothing to some 76,000 KW. This demand taken in conjunction with the existing heads at the two power sites in San Francisquito Canyon will require a flow of water varying from nothing up to 1,000 sec.-ft., while at the same time the total amount passed per day must correspond to an average flow of 400 sec.-ft. as in other parts of the aqueduct.

(d) To provide for this variable flow at these sites while at the same time insuring the necesary continuous daily average flow throughout the entire length of the aqueduct, provision is made for adequate storage reservoirs above and below these sites. The function of these reservoirs will therefore be to permit of the regulation of supply in accordance with the demand, while in addition they will have a capacity sufficient to provide a guarantee against interruption of service due to accidents or repairs on the aqueduct line between the Fairmont and Haiwee Reservoirs.

These arrangements will effectively provide for the close adjustment of power output to demand, and within the capacities above stated should obviate the necessity of any steam plant either for relay or for carrying peak loads.

VALUE OF POWER AS DEVELOPED.—The value of water-power development depends, in general terms on two main features: (a) Regularity and reliability of service, thus commending the power to the purchaser and thereby securing the most favorable conditions of sale; (b) low first cost and low costs of operation and maintenance.

Among the conditions which bear on the question of reliability the following may be enumerated:

(1) The general plans, which are under consideration, contemplate the utmost possible reliability in all constructions relating to the hydraulic development. There will be no side-hill work involving risk to conduit by slides. For all parts of the line under pressure, the water will be carried either in concrete-lined tunnel or in steel pressure pipe. Elsewhere the water will be in concrete tunnel or conduit in accordance with the designs which have been developed in connection with the general aqueduct project.

(2) A point of special importance is found in the diversion and handling of the water along the line of the aqueduct, entirely removed from possible influence or interruption by torrential streams. Adequate storage reservoirs will also insure a steady flow throughout the year thus eliminating possible interruptions or irregularity of service due to an annual low-water period or to the vagaries of stream flow. In brief, the entire program of water flow, with reference to power development, will be under complete control with reference to power demand and will possess the maximum possible reliabilty and regularity throughout the year independent of seasonal changes which exercise so important an influence on the reliability and regularity of service under the usual conditions of hydraulic-power development.

(3) Special provision through the appropriate combination of surge chambers, relief valves and suitable regulating devices will be made for the safeguarding of all pressure lines from undue shock due to variable velocity of flow.

(4) The subdivision of the power development among seven or more power sites, distributed along the line of the aqueduct and its feeders, will permit of certain periods of overhaul and repair among the various plants without serious interruption in the delivery of power at the terminal point in accordance with the demands of the daily-load curve.

(5) As an aid in the prompt examination and overhaul of all power units and of their gates and control valves, special attention will be given to the most effective location of shut-off gates and by-passes.

(6) In regard to the transmission lines it should be said that climate, topography and accessibility for construction, patrol and manitenance along the right-of-way are more favorable than those generally met with in similar undertakings elsewhere. Especially is this true in regard to freedom from electrical storms and the presence of large birds, which are specific causes of many temporary interruptions of service over similar transmission lines in other regions.

Fig. 2 gives, to scale, the location of the generating stations and the transmission lines that will bring power to the city. These conditions are such that the total daily energy delivered to the city will be transmitted over the moderate average distance of 65 miles, while the corresponding average distance for the energy at the time of maximum power demand will be 55 miles.

An aggregate of 9,200 KW.-hrs. will be generated continuously at points that are 162, 185, and 225 miles from the city. Ordinary transmission lines for such distances require special facilities such as synchronous condensers, or their equivalents, to control power factors and regulate terminal voltage. In the present undertaking the stations near the city will perform the duty of regulating the distant power sources with a corresponding increase in reliability, effectiveness and economy.

Electrical power for purposes of construction has been distributed along the line of the aqueduct route at 30,000 volts during the past two years. Through this construction service your Electrical Engineers have acquired a thorough knowledge of the natural features of the country through which these transmission lines must pass and this knowledge will be an effective aid in establishing transmission lines of improved reliability. Recent practice in long-distance transmission of power corresponding to these conditions has developed likewise much valuable experience relating to methods and details that contribute greatly to increased reliability of transmission lines.

Among the conditions which justify anticipation of moderate or low cost of operation, the following may be mentioned:

(1) All conditions which make for reliability of service are, at the same time, favorable to low costs of operation. These various conditions have been mentioned already.

(2) The lack of need for a steam plant as already noted.

(3) The development of some 70% of the power in two large blocks of about 46,000 KW. and 30,000 KW., maximum amounts respectively, thus minimizing superintendence and labor charges.

(4) The relatively close proximity of the main blocks of power to the City of Los Angeles, as indicated by preceding statements.

RECOMMENDATIONS.—Regarding the program for the development of this power project we would suggest in general a progressive development at such rate as the growth of the power market may justify. Regarding the first step in such program we would point out that the demands of the aqueduct project by itself will require certain items of installation at the power sites needed for simply passing the water. In order to avoid temporary present constructions, with their additonal cost, we would therefore recommend as a first step the installation of all such portions of the equipment as may thus be required for the aqueduct project itself, together with the full development of one or more power sites as further study may indicate.

We understand that the city is about to proceed with a bond election covering an issue of $3,500,000, and would state that in our opinion such a sum is well suited to the probable demands of the first step of the program as above outlined.

The Use of Steel Ties on Electric Railways.*

TWIN CITY RAPID TRANSIT CO. (Geo. L. Wilson, Chief Engineer).—We have in use about 1,000 Carnegie steel ties. These were all laid on straight line, about half on a street which had a macadam surface and the balance on a street paved with brick, where the ties were embedded in concrete. All on tangent. This work was all located in St. Paul. They have been in use about one year. The street grade is approximately 1%. In the paved street we have had no difficulty in regard to the ties holding the track. On the macadam street, the ties did not seem at first to hold the track rigidly, but seemed to work somewhat in the stone ballast. We have had no notice of trouble from this cause recently.

UTICA & MOHAWK VALLEY RY. (M. T. French, Engineer of Maintenance of Way).—We have used 100 Carnegie steel ties having top flange 4½ ins., bottom flange 8 ins., height 5½ ins., length 7 ft. We have used 4,572 Carnegie ties having flanges 4 ins. and 6 ins., height 4¼ ins., length 7 ft. Of this number, 625 were used under 7-in. 95-lb. tee rail; 297 under 7-in. 70-lb. tee-rail; 1,062 ties under 100-lb. Am. Soc. C. E. open-hearth rail; 2,706 under 95-lb. 9-in. tramhead girder rail. All of these ties were used in our standard concrete construction, paved with standard vitrified block grouted with Portland cement.

JOLIET & SOUTHERN TRACTION CO. (L. D. Fisher, Chief Engineer).—We have 300 of the Carnegie ties in paved streets, with 7-in., 80-lb. tee-rail, and spaced 5 ft. c. to c. The tie and the base of the rail are all embedded in Portland cement concrete, with 6 ins. under the tie. Under these conditions our track maintains good surface and gage.

BOSTON ELEVATED RY. (A. L. Plimpton, Civil Engineer).—We have under this form of tie only on a short length of track on Washington St., in connection with relaying the tracks last season on concrete base. The ties are particularly well adapted to such work, as track is bonded much better to the concrete than in the case of wooden ties.

SYRACUSE RAPID TRANSIT CO. (E. P. Roundly, Engineer Maintenance of Way).—We have several thousand

*From the report of the Committee on Ties, presented at the annual meeting of the American Railway Engineering and Maintenance of Way Association, held at Chicago, March 15, 17, 1910.

Carnegie ties in use; all in paved streets, with concrete ballast.

VIRGINIA PASSENGER & POWER CO. (Calvin Whitely, Jr., Chief Engineer Railway Department).—We purchased 300 or 400 Carnegie ties some months ago with the intention of putting them under our tracks, in concrete, in one of our carbarns, but as yet have not used them. We have used several thousand of the Pennsylvania and the Lorain steel ties in concrete with good results. We like the appearance of the Carnegie tie better, but do not like its method of fastening the rail to the tie.

CHICAGO CITY RY. (H. B. Fleming, Chief Engineer).—We installed the Carnegie steel ties in Cottage Grove Ave., between 40th and 71st Sts. in the fall of 1907. They are laid 4 ft. c. to c., surrounded by concrete, and support a 9-in., 129-lb. rail. The right-of-way is paved with granite. The maximum grade on the street is about 1%.

DENVER CITY TRAMWAY (John Evans, Chief Engineer).—We have used 2,500 Carnegie ties, all laid in May, 1908, all in conjunction with concrete paving, and all in straight track. To date, track held to perfect surface, gage and line. Wherever the steel tie has been used with a concrete pavement, we have experienced trouble from cracking of such pavement.

OKLAHOMA RY. (W. A. Haller, General Manager).—We have about four miles of 6-in. base Carnegie steel ties in concrete street railway construction. We have none in ballasted roadbed. We have found that the one bolt clip used for attaching the rail to the tie is inadequate, even in a paved street, and we judge it would be still less reliable when used in open track construction. We have experienced some trouble with joint ties working loose in the concrete, the primary cause of this being that the attachments and rail joints first become loose, and the vibration and jar then cause the tie to work loose in the concrete. In our recent construction, however, we are using a continuous rail joint and exercising more care in placing the concrete.

A Coal Meter for Measuring the Flow of Coal Through a Chute.*

The accompanying half-tone (Fig. 1), shows a device designed to measure the flow of coal, grain or other similar materials. As a coal meter it would be of use, among other things, in analyzing the consumption of different units of a battery of boilers or in checking the quantity of coal delivered by dealers to private plants.

The meter consists of a short shaft with

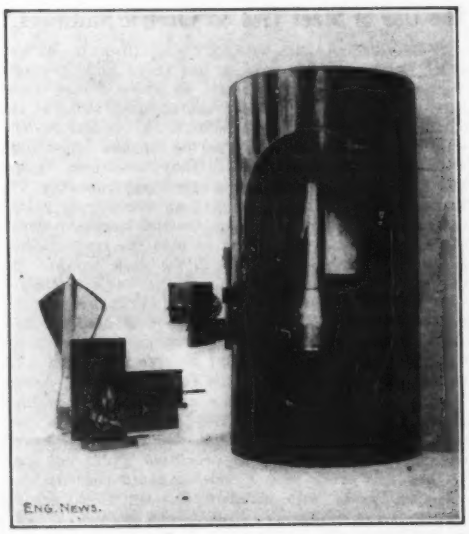


Fig. 1. Havard Coal Meter Mounted in Section of Chute.

(One side of the chute has been cut away to show the meter. The view of a separate meter at the left shows the revolution counter and worm gearing.)

two helicoidal blades resembling those of a marine screw propeller except that the pitch is much more gradual. The shaft is held longitudinally in a section of round pipe in the chute system well above the point of delivery. The chute is arranged so as to be kept full of material at all times so that the screw is always fully immersed. As material is withdrawn from below, the downward motion of the full column of coal in the chute causes the screw to rotate. A suitable arrangement of worm gearing transmits the motion of the screw to a revolution counter mounted outside the chute. This counter can, of course, be made to read directly in tons, pounds, cubic feet, bushels or other units as desired.

The rotation of the screw is very closely proportional to the quantity of material withdrawn through the chute, as is evident from the accompanying graphical record of calibration tests (Fig. 2). Meter No. 7, of which the calibration curve is shown, is one of 14 which have been in constant service, for several months, on the chutes serving seven boilers. The tests whose results are recorded in Fig. 2, cover a period of two months and indicate that the meter's accuracy is not appreciably affected by wear.

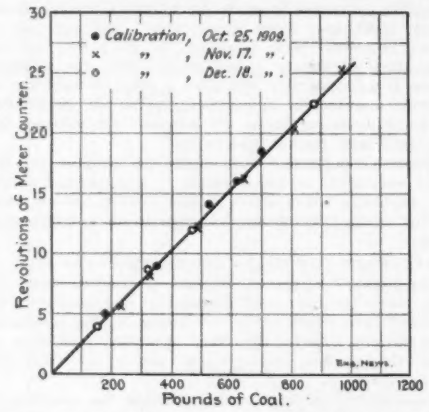


Fig. 2. Calibration Curve, with Results of Three Tests of a Havard Coal Meter at Intervals of About One Month of Constant Use.

Several of these meters have been in use for some time in power plants of the Lackawanna & Wyoming Valley R. R., at Scranton, Pa., the Scranton Electric Co., and the Wilkesbarre Gas & Electric Co. In all of these plants the meters are used to measure small anthracite coal and are reported to have given very satisfactory results.

This device has been patented by its inventor, Mr. O. D. Havard, of Scranton, Pa.

*From information furnished by the O. D. Havard Co., 643 Adams Ave., Scranton, Pa.

Discussion on Tests of 15,000-KW. Interborough Engine-Turbine Unit at Meeting of American Society of Mechanical Engineers.

The paper on a "Test of the 15,000-KW. Steam-Engine-Turbine Unit in the Power Station of the Interborough Rapid Transit Co., New York City," by H. G. Stott and R. J. S. Pigott, which was published in our issue of March 10, was presented for discussion at the March meeting of the American Society of Mechanical Engineers held at the Engineering Societies' Building in New York City March 8. The American Institute of Electrical Engineers was invited to cooperate in this meeting and the session was held in the large auditorium on the third floor. The attendance was estimated at about 670. In the absence of the President, Mr. I. E. Moultrop, of New York City, presided.

The text of the paper was presented in abstract by Mr. Stott, after which Mr. Pigott discussed the tabulated data and curves comprising the second part of the paper. In this connection, Mr. Pigott described some of the technical features of the work of testing the large units. The condensed steam was weighed on scales graduated to 5 lbs. in tanks holding 25,000 lbs. No gages were used for measuring steam pressures, but instead the steam temperatures were ascertained by means of accurate thermometers. This substitution was practicable because of the fact that no superheated steam is used in the power plant. Mr. Pigott believed that pressure gages were not to be relied upon. On the lower pressures, mercury manometers were used.

The methods of calorimetry at low pressure were especially interesting. It was necessary to determine the quality of the steam entering the turbine nozzles in order to see that the turbine was fulfilling its guarantee. Since this steam was at nearly atmospheric pressure, it was possible to utilize the ordinary throttling calorimeter only by taking advantage of the condenser vacuum, which was brought into communication with the exhaust side of the calorimeter orifice. Results were checked with a combination of a separating and a throttling calorimeter. The ordinary perforated tube for sampling was found to be useless for the low-pressure steam, as it could not be made to give a true sample. The sampling tube finally adopted was shaped somewhat like a pitot tube with an easy curve in the direction of steam flow at the end. This tube had at the end a single orifice with knife edges. With this tube results could be duplicated, under the same operating conditions, within about 0.2 to 0.3 of 1%.

Dr. C. P. Steinmetz, of Schenectady, N. Y., spoke of the great commerical importance of the combination of low-pressure turbines with "asynchronous" or induction generators. In his usual concise interesting way he described the characteristic construction and operation of these generators, which are essentially only induction motors driven here by low-pressure turbines. As such a machine has no inherent arrangement of magnetic poles, its magnetic field is produced only by the reaction of the alternating currents generated or fed in by other machines. This makes it necessary that such generators be run on a system which includes the older familiar "synchronous" machines having definite poles excited by direct current. There is no magnetic field in the induction generator dependent on terminal voltage and the regulation is independent of the load. On open circuit no voltage is generated by these induction generators, and on short circuit there is no current as the field disappears. The voltage regulation of a combined system of asynchronous and synchronous machines is then simply a regulation of the synchronous apparatus. The former apparatus is therefore ideal to "float" on another alternating-current generating system, to receive mechanical power and converting it to electrical.

Mr. Max Rotter, Mechanical Engineer of the Allis-Chalmers Co., Milwaukee, Wis., expressed surprise that no difficulty was experienced with oil in the exhaust steam. No reference to this subject was made in the original paper nor in Mr. Pigott's discussion. He also wished to know what would be Mr. Stott's opinion regarding a similar combination of reciprocating engines and low-pressure turbines as an original installation. In regard to the curves in which actual performance was compared with guaranteed water rate, he remarked that nobody was going to make guarantees any lower than was necessary to get just a trifle ahead of competitors, and that steam-turbine water rate guarantees could generally be bettered in actual operation by about 2 lbs.

Mr. Junggren, Turbine Engineer of the General Electric Co., called attention to the high cost of the combined engine-turbine unit. If it were allowable to expend an equal amount on a high-pressure turbine, the present results might be equalled at full load. The engine-turbine unit was undeniably superior under the variable load conditions existing at the Interborough station because of the remarkably flat water-rate-load curve. The flatness of the curve was due to the engine's maximum efficiency occurring at somewhat lower load than that of the turbine.

A written discussion sent in by Mr. J. W. Lieb, Jr., of the New York Edison Co., which was read by the secretary, called attention to the high heat transference attained in the condenser during the tests and to the space conditions at the Interborough station. The circumstance that the low-pressure turbines could be installed in this case without enlarging the power-house was a determining factor in the decision in favor of the engine-turbine combination as opposed to high-pressure turbines. Such space convenience would not generally be met with nor would this factor enter into the question in choosing the type of unit for a new station.

Dr. D. S. Jacobus, of Stevens Institute, mentioned that he had visited the plant during the

test and testified that the attention to details and thoroughness in striving for the utmost possible accuracy which he saw did his heart good. In his opinion, the present installation could not be surpassed in economy by gas engines under such trying load conditions.

A written discussion sent in by Mr. W. L. R. Emmet, of the General Electric Co., Schenectady, N. Y., described briefly an engine-turbine plant at Schenectady in which the engine exhaust was led to the turbine through 200 ft. of horizontal pipe with a separator at the end near the turbine. Practically dry steam was secured for the turbine in this way. In the Interborough tests, probably the best possible results were not obtained from the turbine owing to the considerable percentage of moisture in the steam supplied to it.

Dr. Steinmetz entered the discussion a second time to explain the relations of the water-rate curves obtained respectively with variable and constant nozzle pressure. In the latter case, the pressure of steam entering the turbine nozzles was kept constant by regulating valves, while in the former the unit was given its head and the nozzle pressure allowed to vary with the rate at which steam was used by the engine, depending, of course, on the load. The conditions for variable nozzle pressure were the more favorable for the engine. Constant nozzle pressure was better for the turbine. The reciprocating engine, however, was more susceptible to the interference with its regular operation than was the turbine. Therefore, to get the maximum combined efficiency of operation, variable nozzle pressure was adopted. This involved the further advantage of greater simplicity. It should be remembered that variable nozzle pressure was favorable to the engine and unfavorable to the turbine because this accounts for the engine's having a higher efficiency than the turbine under the conditions adopted for regular operation.

Dr. Steinmetz considered that the comparison between high-pressure turbines and the engine-turbine units was scarcely fair if taken to apply generally for the reason that only saturated steam was considered in connection with the Interborough installation. High-pressure turbines would gain more by the use of superheated steam than could the engine-turbine combination.

Mr. C. O. Mailloux, of New York City, regretted that the low-pressure turbine was not more generally utilized for improving poor engine installations as well as good ones. Referring to Mr. Rotter's query as to oil in the exhaust, Mr. Mailloux spoke of an engine of about 1,500 KW. which he had seen in Europe operating successfully with graphite lubrication. Graphite was supplied at the rate of 1/10 oz. every eight hours. Piston rings of a special alloy were used and had a life of 4,000 engine hours.

There was more or less not very well supported objection to the statement in the paper that an equivalent gas engine plant would have "a probable maintenance and operation account of from four to ten times that of the steam turbine."

Mr. Stott, in making his concluding remarks on the discussion, declared that the above statement had been inserted in the hope of eliciting more information on the subject of gas engine maintenance. Gas engines, he said, were all right—while running. Until it was definitely disproved, he stood by the statement in the paper. In answer to Mr. Rotter's inquiry, he explained that oil separators had been obtained which reduced the oil content to 0.4 grain per gallon of condensed steam. No general statement could be made concerning the advisability of putting in engine-turbine units as original installations. He would say, however, that in the case of low load factors the higher efficiency would be of slight importance since the chief consideration in such a case would be the fixed charges.

Mr. Stott commented humorously, on Mr. Mailloux's suggestion regarding poor engines, that the more steam an engine used the larger low-pressure turbine could be added. Thus the power output might be increased more than 100% in some cases. In conclusion, he called particular attention to the fact that the tests were made not under uniformly regulated rheostat loads but under actual operating conditions of load varying constantly through considerable ranges due to train movements.

Committee Reports; American Railway Engineering and Maintenance-of-Way Association.

The several committees of this association prepared no less than 20 reports for presentation at the annual meeting, and while a few of these were brief, the great majority were of considerable length. All this material was printed and distributed in advance of the meeting. A general statement of their subject-matter is given in our review of the proceedings, but it is manifestly impossible to deal with all these reports in any detail. We give herewith, however, some extracts dealing with individual subjects, while more extended extracts of some of the reports will be given separately.

The Design of Passenger Terminal Stations.*

There is a growing demand on the part of the public for new passenger stations of the most modern type, and this applies to small towns as well as large cities. In the aggregate the demands are enormous. It is very generally assumed that this will benefit the railways; but, as a matter of fact, the expenditure returns no revenue, and involves increased annual expense for maintenance.† It is therefore economy to use the existing facilities as long as they will handle the business, but a few hundreds or thousands of dollars spent judiciously in improvements that will facilitate the handling of business, or will benefit or appeal to the public convenience and comfort, may be a wise investment. These improvements would apply especially to the track layout connecting the main line approach with the station tracks; also the ventilation, lighting, and particularly the sanitation of the station. Some new stations have been criticised on the ground that they have been made excessively expensive by unnecessarily elaborate architectural and decorative features.

When increased traffic necessitates the enlargement of passenger terminal stations the usual method is to widen the station and provide additional tracks and platforms. In certain cases this is impracticable, and there is then a choice between increasing the length and using a double-deck arrangement. In two or three cases in this country the latter has been adopted, notably in the New Grand Central Station of the New York Central Ry. at New York. Here the main track level is below the streets, and the suburban track level (approached by inclines) is beneath it and at the level of the city's underground rapid transit lines. In the South Station at Boston, with the main tracks at the street level, there is a suburban terminal at the basement level, though this is not used at present.

In the case of stations having tracks above the street level, it has been suggested that by closing one or two streets, the suburban lines might be brought into a terminal at the street level (beneath the main track station). In one instance, where it was proposed to bring an interurban electric system into a main line terminal, the plan was to build an elevated electric line over the steam tracks and leading to an upper floor in the train-shed. In two cases in Great Britain, double-length platforms for two trains have been used.‡

LOOP TERMINALS.—The loop arrangement of terminals has been used extensively for electric railways and rapid transit lines, but only to a small extent for steam railway service. In the Grand Central Station at New York, there will be a suburban terminal on the lower level, with 15 parallel tracks (arranged singly and served by 16 platforms), all served by a double-track loop of 137 ft. radius. There will be a loop also for the express tracks. The South Station at Boston was designed with a double-track loop terminal for suburban traffic on the lower floor; in this case the platforms are on the loop itself, which has a radius of 250 ft. These loops have not yet been put in service, although the station was built about 12 years ago.

The Pennsylvania Ry. will have at Harrison, N. J. (the west end of the New York terminal improvements), a curve of 656 ft. radius. This can be used by the steam locomotives, the electric locomotives, and the rapid transit equipment either separately or in trains. The Boston & Maine Ry. has at Rockport, Mass., a loop which is used many times daily for turning passenger trains which are handled by large locomotives. Its purpose is to reverse the trains, the terminal station itself being of the dead-end type.

An interesting case of the operating of a local service on a circle or belt system is that of the service between Albany and Troy, N. Y. The Delaware & Hudson Co. owns a double-track line on the west side of the Hudson River, and the New York Central Ry. owns a line on the east side of the river. In 1882, an agreement was made whereby each road started the operation of a loop service, running alternately in opposite directions; that is, a train goes out over the New York Central Ry. and comes back over the Delaware & Hudson Ry.; and another train goes out over the latter road and comes back over the former. This arrangement has worked very satisfactorily and has furnished adequate service between the two cities. The trolley lines have cut into this service to a considerable extent since it was inaugurated.

*From the report of the Committee on Yards and Terminals.

†This question was discussed at some length in Engineering News of Oct. 28, 1909.

‡Particulars of the arrangements are given in Engineering News of Feb. 11, 1909.

Records of Ties and Tie Renewals.*

It is the opinion of the committee that if the blank forms as recommended were put into use by railway companies and the information accurately given, valuable statistics of ties would be obtained, and this information would be of much benefit to the management of roads in determining their course in the matter of cross-ties for future use. The committee believes that its future work should be confined to such railways or officers as may be interested in the matter, and to obtain from them data that will aid in determining the life of ties from certain known conditions. From this information we can obtain the life of ties of the different kinds of wood under varying climatic conditions.

E. O. Faulkner (Manager of Tie and Timber Dept., A., T. & S. F. Ry.).—In attempting to keep statistics of the life of our ties, based on reports from every individual section of the road, I believe we are trying it on too big a scale. There are too many contingencies of one kind and another that render our average unreliable, and consequently misleading. I have tried it for five years with nearly 1,400 sections, and find it is not a success. I now have asked our vice-president to let us establish two (or three) representative sections on each superintendent's division, and let the averages from these stand for those of the division. We can watch these closely and get more reliable figures by far than under the larger plan.

J. L. Campbell (Engineer Maintenance of Way, El Paso & Southwestern System).—I have recommended to our management that we discontinue the use of dating nails and adopt the plan of inserting lots of all treated or all untreated ties at various mileposts on the several roadmasters' districts, and then require an accurate and reliable record of the life, service and renewal of those particular ties.

I have little confidence in the value of our weekly, monthly and yearly tie-renewal reports in the matter of giving accurate data touching the kind, preservation and renewal of ties. Each section foreman, under the rules, is obliged to account for every tie taken out of the track; whether it was treated or untreated, the year inserted, the year taken out, cause of removal, etc. They do submit such accounting, but I have noticed that all over the system large numbers of dating nails have disappeared from the ties and that many of the heads are broken off.

From all this I am satisfied that the sectionmen generally have to do an amount of guessing quite sufficient to very seriously vitiate the record. When a dating nail is driven into a tie which presumably will last 12 or 15 years, I have but little confidence in it being there at the end of that time in a condition to afford an accurate record. I am quite sure that a sufficient number of such nails will have disappeared or become illegible in that time to make the record quite imperfect.

On the other hand, if certain definite numbers of ties of certain kinds are placed in the track within certain limits a much more accurate record can be had. The objection to this method, of course, would be that it would have to be assumed that those particular ties accurately represent the conditions of service and life of the ties over the particular district in which they would be located.

Hermann Von Schrenk (Supervisor of Timber Preservation, St. Louis & San Francisco Ry.).—We are not using the blanks recommended by the Association, and I very much doubt whether we could adopt such forms without further careful consideration. The keeping of tie statistics is almost impossible, owing to the fact that we have to depend upon the section foreman to keep these accounts, and, in view of the constant changes among these employees, errors creep into these records which it is impossible to correct or take into account.

The only value which such record has is to enable us to compare the relative length of life obtained on different sections of the same system. This we can do much better by establishing test sections in various parts of the country, such sections to be more or less typical of certain geographical territory. In this matter, we can keep accurate records not only of the various

*From the report of the Committee on Ties.

treatments, but also of the kind of wood used and any special peculiarity of wood and treatment.

H. A. Kennedy (Assistant General Manager, Great Northern Ry.).—We have been endeavoring for the last few years to keep similar records. Theoretically these are useful, but practically they are of little value, so far as our experience has gone. We find that section foremen frequently fail to give all the information called for on the blanks. It is difficult for them to furnish information unless we have some means of preserving the identity of the kind of wood, and of the date placed in track. Some three or four years ago we inaugurated the system of placing a small dating nail in the ties put in track each year, which helps the situation a little. On the whole, it seems that the information sought is so complicated that we have considerable difficulty in schooling our foremen to fill in the forms with correct data. Our foremen, as a rule, are not very intelligent, and they change frequently.

Our experience during the past two or three years has been that we were practically compelled to use such ties as were made along or in close proximity to our tracks, irrespective of the quality of wood. On this account the information which is being sought in these forms is of little value. They are, however, useful to the extent of showing in a general way the value of various processes of timber preservation. There is some question as to whether the information obtained is sufficiently reliable to warrant the expense incurred in compilation.

Coaling Stations and Tool Houses.*

REINFORCED-CONCRETE COALING STATIONS.—The cost of reinforced-concrete coaling stations averages about 50% greater than that of timber structures of like capacity.

It would seem that the use of the reinforced-concrete type of coaling stations and storage bins is increasing. In many cases, no doubt, the freedom of this type from the danger of the loss of the structure and contents by fire due to spontaneous combustion of soft coal will cause many engineers to install one or more of those structures so that they may have a practical test of their efficiency.

SECTION TOOL HOUSES.—The house should be 14 × 20 ft. (12 × 16 ft. for roads of medium traffic), with long dimension parallel to track. House to have sliding door ft. in clear at extreme end on track side to permit the storing of hand car.

Building to be on wooden posts, unless the location can be permanent, in which case brick or concrete piers may be substituted for posts. The building to be covered with drop siding. Roof to be slate or asbestos shingles. (It is considered specially dangerous to have the ordinary shingle construction on buildings of this type.) Window openings on two sides and sliding shutters. (No glass to be used in windows or doors.)

For roads of light traffic, the building should be 10 × 14 ft., with the short dimension parallel to the track, and having in the side facing the track double swinging doors to open outward.

All the buildings 8 ft. high to top of wall, and 8 ft. clear from the nearest rail.

Roof Coverings.*

TILE.—A roof of well-burned tile properly laid is probably unexcelled for a pitch of 6 ins. or more to the foot. It is so heavy in appearance that ordinarily it does not look well on a frame building.

SLATE.—A slate roof is cheaper and lighter than tile. It will give results almost as good and can be used satisfactorily on wooden buildings. The pitch should not be less than for a tile roof.

WOOD SHINGLES.—A wood shingle roof properly laid and of good material will last for many years. First-class shingles can still be obtained from the Pacific coast for a reasonable price. If dipped in linseed oil or creosote, their life will be considerably increased. Painting after laying induces decay and should be avoided. When the roof is old and a little out of shape it is somewhat dangerous, providing a chance for the lodgment of sparks. The pitch should be at least 6 ins. to the foot.

TAR, FELT AND GRAVEL.—Roofing built up of felt saturated with coal tar, cemented together with coal-tar pitch and covered with a protective coating of gravel or slag, has shown by long experience its great serviceability for flat surfaces. One arrangement suggested to insure the specified quantity of materials is to weigh all materials which come onto the work and insist on the proper amount being used.

No specifications for coal-tar pitch and saturated felt are available, and the only assurance of good quality is the guarantee of the manufacturer.

With a proper foundation, a coal-tar roof perfectly flat, covered with water, would theoretically have an indefinite life. The steeper the pitch, the more chance there is for the gravel or slag to be washed off and for the pitch to run in warm weather. Crushed material, such as quartz, with rough edges, is better than rounded gravel for covering steep slopes.

Asphalt is used for this purpose. It is, of course, variable in quality. It is claimed that its volatile constituents are so great that it deteriorates gradually. It seems to be relatively of more value for steep slopes than for flat surfaces.

READY ROOFING.—The roofings which come ready to lay are made on the principle of the above built-up roof, but in a preparation which comes rolled it is impossible to get the amount of waterproof material deemed necessary for a good built-up roof. Asphalt is generally considered better for this purpose than coal tar.

The weakness of this type of roof covering lies also in the exposed lap and nailing and in the narrow lap. These coverings are valuable because of their economy for small, isolated and temporary buildings. They do not require the expert help required for a built-up roof.

TIN.—A tin roof can be used for almost all slopes, and if properly and frequently painted, gives good results, where it is not exposed to locomotive gases. Its maintenance is, however, expensive. It can be easily damaged and it is not suitable for railway purposes except under special conditions.

PATENT SHINGLES.—There are on the market various types of metal and composition shingles. Reinforced concrete slabs from 5 to 6 ft. long have been used for this purpose. Corrugated iron, asbestos boards, asbestos-protected metal and tin or galvanized iron shingles are among those offered for sale.

*From the report of the Committee on Buildings.

Switches, Frogs and Track Fastenings.*

SWITCH POINTS.—As the association has adopted 33 ft. as the standard length of rail, the committee recommends switch points 11 ft., 16½ ft., 22 ft. and 33 ft. long; the last three will most nearly meet ordinary requirements. The length should be 11 ft. with frogs up to and including No. 6, 16½ ft. up to and including No. 10, 22 ft. up to No. 14, and 33 ft. with frogs over No. 14.

FROGS.—Three frogs are recommended to meet all general requirements: No. 8, No. 11 and No. 16.

Considering that the frog angle is the angle between the gage lines of the point rails, that the axis of a frog is the line which bisects that angle, and that the spread of a frog is measured at right angles to the axis, the number of the frog is the number of units measured on the axis in which the frog spreads one unit, from which the frog number is one-half the co-tangent of one-half the frog angle.

The installation of frogs upon the inside of curves is to be avoided wherever practicable, but where same is unavoidable, the following rule should be modified in order to make the track standard gage at the frog.

GAGE ON CURVES.—Curves of 8° and under should be standard gage. Gage should be widened ¼-in. for each 2° or fraction thereof over 8°, to a maximum of 4 ft. 9¼ ins. for tracks of standard gage. Gage, including widening due to wear, should never exceed 4 ft. 9½ ins.

TIE-PLATES.—Tie-plates should be applied in all cases where greater economy in maintenance is secured by their use than in depending on the life of the tie, limited by rail wear.

Shoulder tie-plates are recommended in preference to rail braces, except for guard rails and stock rails at switches, where the latter should be used.

For heavy traffic, shoulder tie-plates should be used on all ties on curves; and for medium traffic on all ties on curves over 3°. For light traffic, the outside of rails on curves should be double-spiked.

TRACK FASTENINGS AND TRACK CIRCUITS.—Where there is material leakage from track circuits, track fastenings should be so designed as to prevent contact between the metal and the ballast.

*From the report of the Committee on Track.

Concrete Fence Posts.†

While American railways have been conducting extengive experiments to demonstrate the economy of the reinforced-concrete post, the art is still in a primitive state. Distinct progress, however, is being made, and another year should produce much valuable information. The following facts have been established and are self-evident propositions:

(1) Concrete fence posts will heave very little and in most cases not at all; posts set from two to five years ago are still in almost perfect alinement.

(2) They appear sufficiently strong for all practical purposes after having been properly cured and set. A cedar post of dimensions identical with the average concrete post would weigh about 25% as much and is about four times as strong when new. But this only brings out the fact that the cedar post is stronger than necessary and that the concrete post with its lesser strength is yet strong enough to serve its purpose, and has a longer life.

(3) The claim that a concrete post reinforced with steel forms a lightning protector appears reasonable.

(4) They resist the action of fire and decay, and will not float and cannot be displaced as easily as wood.

(5) They must be handled carefully in loading and unloading, and be well cured before being set.

(6) They are much heavier than wood posts and the cost of distributing and setting is about 25% greater.

It is reasonable to assume that, since concrete has supplanted wood and steel for a great variety of purposes, it will also do likewise in the case of fence posts. It only remains to produce a really practical post from the view-points of economy and utility to bring them into general use. They will naturally have to be made by machinery. There are already a number of cheap portable machines on the market.

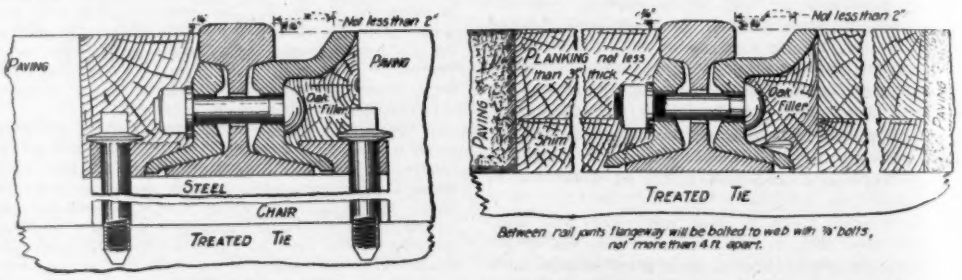
†From the report of the Committee on Signs, Fences and Crossings.

The Construction of Railway Grade Crossings*

Owing to the well-known difficulty of maintaining the track in proper surface through and adjacent to grade crossings, a form of construction should be adopted that will tend to remedy this trouble by requiring a minimum amount of labor and material to be expended in repairs or renewals. This construction will necessarily vary with conditions, but can be divided into the following general classes of crossings: (1) where paving is required to conform to street specifications; (2) where no paving is required; (3) public roads or highways outside of towns or cities; (4) private or farm roads.

(1) At crossings where paving is required to conform to street specifications, treated ties should be used, laid on a bed of crushed rock, gravel or other suitable material not less than 12 ins. in depth, placed in 3-in. layers, each thoroughly rammed to prevent settlement. Vitrified tile drains not less than 6 ins. diameter, leading to nearest point from which efficient drainage may be obtained, should be laid on either side of and between tracks, parallel with ballast line and outside of ties.

Where block paving of greater depth than the height of the rail is used, a substantial malleable iron or steel chair, with base not less than 48 sq. ins., should be provided, the rail to be fastened through the chair to the tie with screw-spikes. On long stretches of track, laid on streets paved with blocks, the use of a special rail section is advantageous to avoid the use of chairs. With such rail, tie-plates and screw-spikes should be used. Where a special rail section is used, the flangeway should



In Paved Streets. In Public Roads Without Continuous Planking.

CONSTRUCTION OF GRADE CROSSINGS AT STREETS AND HIGHWAYS.

be rolled as a part of it. Top of rail should be ¼-in. above paving.

A suitable form of rolled metal shape should be fitted into the space between the head and base of the track rail to provide a flangeway of not less than 2 ins. (as shown in the accompanying cut). The ends should be beveled and bent inward to make an opening of not less than 4 ins.

A strip of timber not less than 4 ins. wide should be placed on the outside of, and fitted to the rail, so as to expose not less than 3 ins. next to rail-head, and should be ¼-in. below top of rail.

Where asphalt paving is used, a construction similar to that for block paving is recommended.

(2) At street crossings where no paving is required, the construction may be either of plank laid the entire width and length, or of plant outside of the rails, and the necessary planking inside to retain suitable filling material with provision for proper flangeway. Drainage should be provided as specified above.

Where the crossing is to be laid with plank the entire width and length, the plank should be not less than 3 ins. thick, shimmed so as to be ¼-in. below top of rail.

*From the report of the Committee on Signs, Fences and Crossings.

A suitable form of rolled metal shape should be used, as specified above.

The intermediate planking should be closely laid and fitted to the metal shape forming the flangeway. The planking should be securely fastened to the ties and the ends between the rails should be beveled. A plank not less than 10 ins. wide should be used on the outside of each rail and the total length of the planking should conform to required street width.

Broken stone, gravel, or other suitable material should be used from the plank outside of the rails for such a distance as may be necessary to properly complete the crossing.

Where continuous planking over the tracks is not required, one plank should be placed on the outside of each track rail and one against each metal shape as above described. Crossing plank should be placed at the ends, and the enclosed space filled with crushed rock, gravel or other suitable material, thoroughly compacted and level with top of planking. The ends of crossing between track rails should be beveled.

(3) At public roads outside of towns and cities, crossing construction should be similar to that for street crossings not requiring continuous planking. Crossings of this character should be level for a distance of not less than 5 ft. beyond the outside planks. The road approach grade on a fill should not exceed 6%. The width of crossings should be not less than 16 ft.

(4) Farm and private crossings should be as described for public roads outside of towns and cities, except that metal flangeways may be omitted, the inside plank being placed not less than 2 ins. from rail. They should not be less than 12 ft. wide.

Life of Treated Ties.

Great differences are found in the life of zinc-treated ties in the track. On some roads they promise to average 14 to 17 years, while on others they are giving out in five to six years. This is fully confirmed by the results of the very recent examination of the experimental track on the Gulf, Colorado & Santa Fe. Ry., in Texas, of treated ties laid from February to May, 1902. The diagram of renewals shows that up to 1909, but 8% of ties Burnettized at one plant have been renewed, while 50% of the ties Burnettized at another plant have given out. Of the ties treated by the Wellhouse process, 5% have been renewed of those treated at one plant and 47% of those treated at the other plant.

These differences must be attributed to the way in which the work was done; the short-lived ties either having been treated when the wood was inadequately seasoned, or the process carelessly carried out, or an insufficient quantity of chloride of zinc injected. It cannot be too strongly pointed out that no adequate results will be obtained with any process unless the work is skilfully and honestly done.

While small quantities of ties are being and should be experimentally treated by various processes, it may be said that only two preservatives are being used in practice: creosote and chloride of zinc. It has been pointed out above that great differences are found in the results of the same process, depending upon the perfection with which the work is done. In creosoting, new methods have lately been introduced in order to reduce the cost, by injecting smaller quantities more thoroughly disseminated in the wood. The results are yet to be ascertained by experience, but it may be pointed out that creosoted ties which have heretofore given good results were treated by the "full cell" process, with 10 to 20 lbs. per cu. ft.

Of the experimental track laid by the Chicago & Northwestern Ry. in July, 1907, The conclusion of the examiners was that at the end of 20 months' service all of the ties were in a perfect state of preservation. There was no noticeable difference in the soundness of the treated and untreated ties. The Northern Pacific Ry. laid test tracks near Maywood, Wash., in the late fall of 1906, and in western Montana, near Plains, in 1907. This track has not been in service long enough to furnish conclusions. The report upon the Texas experimental track is the most interesting and valuable thus far received. [We summarise the results in the accompanying table.—Ed.]

RESULTS OF TIES ON AN EXPERIMENTAL SECTION OF TRACK ON THE GULF, COLORADO & SANTA FE RY., IN TEXAS. LAID, 1902; INSPECTED, 1909.

		Number of ties (various species)				
		Remaining in track, 1909				
Process.	Laid 1902.	Good.	Split.	Unsound.	Decayed.	Total.
Allardyce	500	276	91	44	56	467
Hasselmann 1,085		28	2	7	10	47
Beaumont oil (open tank)....	142	3	..	4	25	32
Burnettizing (A)	435	215	101	62	23	401
Burnettizing (B)	515	160	51	21	25	257
Spirittine	200	17	3	..	2	22
Wellhouse (A)...	486	292	108	48	16	464
Wellhouse (B)...	513	176	27	40	29	272
Zinc-chl. & Beaumont oil.....	181	107	53	15	6	181
Zinc-chl. & English oil.....	515	73	21	7	1	102
Untreated.....	905	13	4	27	18	62

Reinforced-Concrete vs. Steel for Short Span Railway Bridges.*

In any bridge the qualities to be desired are: (1) adequate strength, (2) freedom from vibration and excessive deflection, (3) economy in first cost, (4) economy in maintenance, and (5) permanence.

The theory of flexure of reinforced concrete is sufficiently well understood to enable safe and economical designs to be made, and experience with reinforced-concrete structures carrying dead loads only has been abundant. Experience with such structures carying heavy live loads and subjected to the shock and vibration of these loads, moving at high speed, has not been so extensive, but reinforced-concrete girders can be designed and built in short spans of any strength required (or likely to be required) by railway loads. In the event of overloading or defective construction, reinforced concrete will give quite as much warning of probable failure as other materials.

While the art of bridge construction in steel has so far progressed that the safeguards surrounding the manufacture of steel and its fabrication into bridges have come to be matters of course, the equally careful supervision of the manufacture of reinforced concrete seems burdensome to the engineer, although it is just as necessary, but not more so. This necessity for careful inspection of methods and materials of manufacture needs to be emphasized, for (like steel) concrete may most easily be ruined by careless workmen. But when the same pains are taken to produce good concrete as are now taken to produce good steel, with the same rigid inspection and insistence on proper specifications, there will result a product which we believe will prove to be equally reliable.

One of the chief advantages of reinforced concrete over steel for short spans is that the form lends itself more readily to ballasted floor construction, the superiority of which to open decks is evident, not only on account of the absence of wood, which may rot or burn, or exposed steel, which requires protection from brine drippings or other corrosive influences, but also on account of the freedom from vibration and excessive deflection, and the reduction of the cost of maintenance to a minimum.

The comparative economy of the two styles of construction is a matter which is not easily determined in general terms, depending as it does upon the market price of steel, concrete materials and labor. The character of the design is also a factor of first importance. Generally speaking, if it is not considered advisable to use ballasted floors in a particular case, for that case the short span of I-beams with ordinary floor of wooden ties is the cheaper construction in first cost. If, however, a large number of similar spans are to be built, so that concrete slabs can be constructed in a central and conveniently arranged plant, and if the erected price of steel work approximates 3 cts. per lb., the difference between concrete slab construction built with ballast floor and steel construction with open wooden floor, will be small, and in many cases will be favorable to the concrete.

If the designs contemplate the use of I-beams embedded in concrete, compared with reinforced-concrete girders, economy will be all on the side of the latter.

Short spans of reinforced concrete also permit a substantial economy in the design of abutments carrying them.

Reinforced-concrete flat slabs or girders are not generally advisable for railway loads in spans exceeding 40 ft. But as the great majority of structures carrying tracks over openings in the roadway are of spans less than 40 ft., the importance of these small structures is very great, and the use of reinforced concrete for these small spans is desirable.

*Appendix to the report of the Committee on Iron and Steel Structures, presented at the annual meeting of the American Railway Engineering and Maintenance of Way Association at Chicago, March 15-17.

The Movement for a National Sewerage Commission.

A few weeks ago a number of engineers and other scientists called upon President Taft and urged the appointment of a national sewerage or sewage disposal commission. It is reported on good authority that a smile came over the President's face as he listened to the reading of the carefully prepared memorial on this subject. However that may be, the result of the visit was a statement from the President that he was powerless to appoint any such commission without explicit authority from Congress, and the suggestion that his visitors and others interested organize an association to conduct such propaganda as it might see fit for the study and prevention of water pollution, and in general to take into cognizance the whole subject of sewage disposal in its national aspects.

This movement for national handling of the sewage-disposal question seems to have originated with Mr. Calvin W. Hendrick, M. Am. Soc. C. E., Chief Engineer of the Baltimore Sewerage Commission. In an address to the Washington Society of Civil Engineers, delivered on March 17, 1908 (see Eng. News March 26, 1908), Mr. Hendrick expressed the opinion that in the near future it would be necessary for the Federal Government to take up the matter of sewage disposal and frame and enforce laws regulating such disposal as related to interstate streams. On Dec. 18, 1909, Mr. Hendrick again took up the subject, in the course of an address before the Baltimore Athletic Club. He then said:

> When you consider the wonderful improvements made in every direction for the comfort, ease and pleasure of mankind, it seems incredible that the sewerage question should have been allowed to take care of itself, with practically no thought, just so it was gotten underground, out of sight, discharging into the nearest stream, letting to-morrow take care of itself.
>
> We are now awakening to find ourselves face to face with this "to-morrow," and will have to pay high for this neglect. Much work will have to be undone; much money expended that could have been saved if undertaken at the proper time.
>
> Now that the whole country is suddenly awakening to this great and serious problem, unless the Government takes hold promptly, on broad lines, and acts as a guiding hand, new and untried schemes will be foisted on the various municipalities, involving the expenditure of great sums of money for work that may have to be done over again. Our country covers such a vast territory, and our streams running from one state to another makes it an interstate proposition, and a question that will have to be studied from many standpoints. A method suitable for one locality may be entirely unsuited to another, on account of *temperatures, rainfall, soils, availability of land and cost.* London is trying chemical precipitation; Berlin, broad irrigation, or farming; while some are trying sand filtration, others septic tanks, stone beds, and various different schemes, some of which are questionable. *I would therefore strongly urge that the President of the United States consider the advisability of appointing a Commission to deal with this great problem as a National one, along broad lines, carefully considering the many localities and the varying conditions necessary to properly safeguard the health of our country and preserve the purity of the rivers and streams scattered throughout our states, territories and possessions.*

These remarks appear to have been followed by considerable correspondence between Mr. Hendrick and others interested in the subject, and the correspondence led up to the call upon President Taft already mentioned. We give below a copy of the letter which was read on the occasion of the visit to President Taft, together with the names of those who not only signed it, but appeared in person before the President:

> The diversion of our rivers and the indiscriminate pollution of our lakes and streams by the discharge of sewage into them is damaging one of our national assets and is rapidly creating a public nuisance. Cities and states are clashing on account of the lack of uniformity in law and practice regarding the disposition of sewage. The method of disposing of sewage in the past has been largely to get it out of sight and into the nearest water as quickly as possible, regardless of consequences, resulting in the loss of many lives and millions of dollars, its disposition being considered a trivial matter, compared to some municipal problems which are more in the public view. Procrastination in this important matter has brought us face to face with extremely serious conditions in certain parts of the country.
>
> The interest of the general public in the sewage problem is widespread and may be exemplified by the large number of delegations of engineers and business men from all parts of the United States, Canada, Mexico, South America, England, Germany, France, Sweden and Japan, some of whom have traveled half around the globe to see how the city of Baltimore is successfully handling one of the most perplexing problems of sewage disposal and pollution of her waterways. These gentlemen came because they are facing serious problems of a similar nature in their own localities.
>
> We feel that the present is the proper time to take up this matter, before our problems have become as serious as those of many foreign countries, thus profiting by their experience. We are confident that such action would be of great benefit in safeguarding the public health and welfare. The problems of sewage disposal are very complex and have been made the subject of extensive experimental study. A large amount of existing and rapidly increasing knowledge relating to it has been only to a small extent actually applied and made available.

After a thorough discussion of this question, the gentlemen composing this delegation feel that the subject is so far-reaching and important that we respectfully suggest to you the appointment of a temporary commission, composed of experts of national standing, who would thoroughly study this question, digest the existing laws on the subject, and report back to you their views and recommendations on questions arising from the diversion and pollution of interstate waters and sewage disposal. We are confident that such a report would be of national assistance in shaping future action and would result in placing this country in the forefront of the nations of the world in this field of sanitation

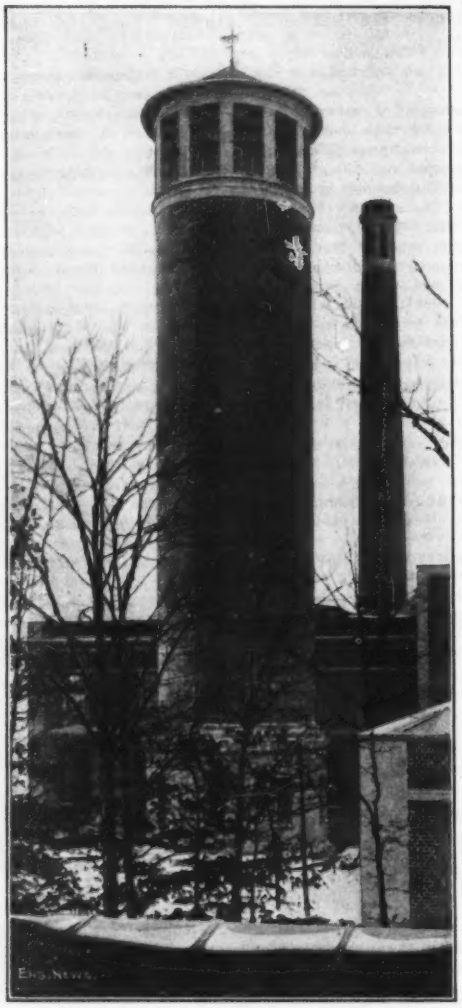


Fig. 1. Brick Water Tower at the Cook County Poor Farm, Oak Forest, Ill.
Holabird & Roche, Architects, Chicago.
Alling Construction Co., Contractors, Chicago.

and further materially aid the solution of the perplexing and intricate questions arising in connection with the diversion and pollution of our state and interstate waters.

[Signed] Dr. William H. Welch, Professor of Pathology, Johns Hopkins University and President-Elect of the American Medical Association; Dr. Ira Remsen, President of Johns Hopkins University and President of the National Academy of Sciences; Calvin W. Hendrick, Chief Engineer of the Baltimore Sanitary Drainage and Purification Construction; Brigadier General George H. Torrey, Surgeon General U. S. A.; Samuel M. Gray, Consulting Engineer on Water and Sewerage, Providence; H. de B. Parsons, Consulting Engineer and Member of the Metropolitan Sewerage Commission, of the State of New York; Bernard N. Baker, Baltimore; Rudolph Hering, Consulting Engineer on Water and Sanitation, New York; Lieutenant Colonel Jefferson R. Kean, Medical Corps, United States Army; Major Frederick T. Russell, Medical Corps, United States Army.

After having been informed by the President that he was in hearty sympathy with their object but unable to appoint a commission as suggested, the gentlemen whose names have been given carried out the suggestion of the President by effecting an organization, with Mr. Hendrick as President and Mr. H. de B. Parsons, M. Am. Soc. C. E. (22 William St., New York City), as Secretary. It is reported that the commission is drafting a Congressional bill for the appointment of a temporary sewerage commission.

Brick Water Tower at the Cook County Poor Farm, Oak Forest, Ill.

A water tower of striking and pleasing design has been completed recently as a part of the group of buildings at the new and extensive Cook County Poor Farm established at Oak Forest, Ill., about 20 miles southwest from Chicago. The general appearance of the tower is shown in Fig. 1, which shows also the power house and brick chimney of the plant. The construction of the tower and the arrangement of the tank, etc., are shown in Figs. 2 and 3. A novel feature in the design is the provision of accommodation for pigeons in the ornamental top portion of the tower, which is shut off from the tank by a concrete floor. There are two rows of nests around the interior of the wall, and two rows of pigeon holes are arranged as shown.

The foundation is of concrete (1:3:5) to within 3 ins. of the ground level, and upon this is built a base course of concrete blocks. The blocks are made solid, of 1:3:5 concrete, with ½-in. top dressing (1:2½) troweled to a smooth surface on the exposed faces.

The base of the tower is built of grey brick laid in cement tempered mortar. The coping and sills are of terra cotta to match the color of the grey brick, and all trimmings are of grey brick. The shaft of the tower is built of dark red brick, laid up in Dutch bond with cement tempered mortar. The roof is of reinforced concrete (1:2:4), covered with slate.

The pigeon loft has a floor of reinforced concrete, supported on I-beams, and the nest boxes are of wooden construction. A spiral stairway with channel iron stringers and cast iron treads extends from the ground floor level to a landing near the top of the tower. The pigeon loft is reached from the landing by means of a ladder and trap door in the floor.

The stand pipe is 15 ft. diameter and 109 ft. high, with a capacity of 100,000 gallons.

The architects for the Cook County Poor Farm are Holabird & Roche, of Chicago, to whom we are indebted for information and drawings. The Alling Construction Co., also of Chicago, has the general contract.

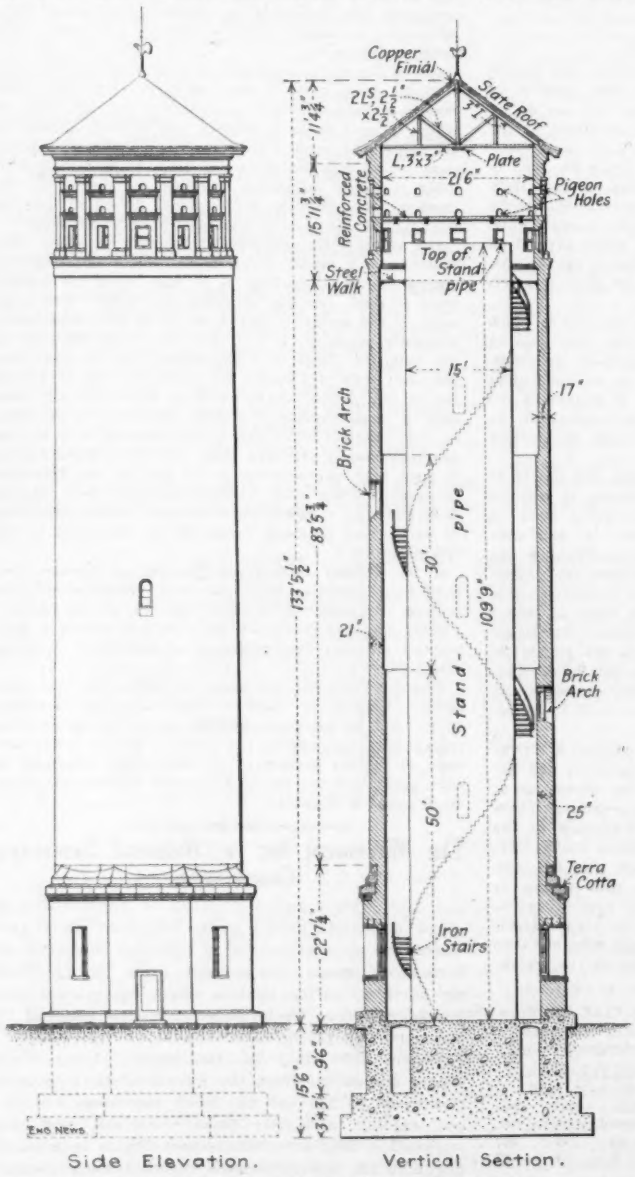


Fig. 2. Elevation and Section of Brick Water Tower with Steel Standpipe.

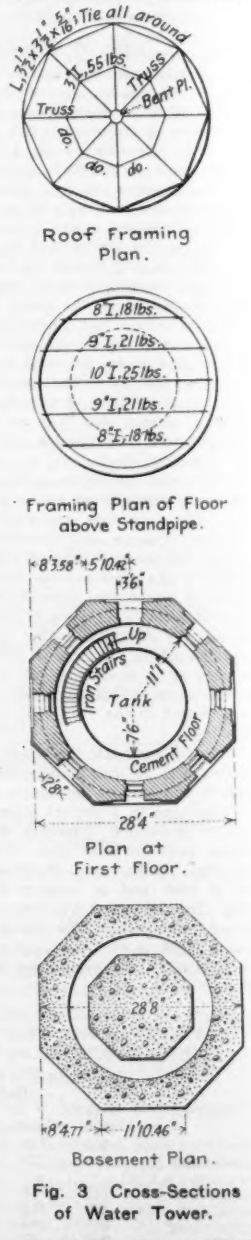


Fig. 3 Cross-Sections of Water Tower.

Railway Bridge Inspection and Erection.*

Bridge Inspection.

Inspection of bridges should be made with the object of discovering weakness or defects, of ascertaining the amount and rate of deterioration, the general physical condition, safety under traffic and the necessity for repairs, reinforcements and renewals.

The frequency of inspections should depend upon the character of the bridges, their location, strength and physical condition. A thorough annual inspection by a competent inspector may suffice for many cases where the bridges have been properly constructed and are not overloaded. On the other hand, a daily inspection may be necessary in order to observe with sufficient promptness damage which may be caused by an accidental blow.

*Abstract of appendices to the report of the Committee on Iron and Steel Structures, presented at the annual report of the American Railway Engineering and Maintenance of Way Association at Chicago, March, 15-17, 1910.

Between these two extremes there are many reasons for making inspections of more or less thoroughness and frequency, but no hard and fast rules, prescribing in detail the manner and frequency of making inspections, could be drawn up which would be alike efficient for the various conditions of traffic, the many types of structures to be inspected, and the widely differing forms of organization of the forces entrusted with the safety and maintenance of railway bridges.

A proper system of bridge inspection should therefore generally include the following:

(1) Inspection by the regular section forces, daily, or as often as they inspect the track under their supervision. The object of this inspection is to discover any damage to the structure from fire, flood, derailments or other accidents from traffic, or any displacement in the structure in whole or in part. This inspection, due to the lack of skill on the part of the section forces, must necessarily be superficial, and will rarely if ever do more than call attention to unsafe conditions arising from causes other than those of natural depreciation. No reports of such inspections need be made unless adverse conditions are discovered.

(2) At periodic intervals of from one to six months there should be inspections by bridge foremen or others experienced in bridge repairs. These inspections should be more thorough than those of the section forces, and are intended to discover all the defects arising from traffic to which the bridge is subjected, and those due to natural depreciation or other causes. Reports of such inspections should be made to the one next in authority; preferably to the one most directly or primarily responsible for the safety of the structures.

(3) Annual or semi-annual inspections are to be made by men experienced in the design and maintenance of bridges; preferably by those who are primarily responsible for their safe maintenance. The reports of these inspections should be filed, and in connection with an examination of office data will determine the safety of the structures, and be the basis for decisions as to repairs, reinforcements or renewals.

The inspections outlined above must be considered as quite general. There will often be cases where much more frequent and thorough inspection will be necessary, especially for structures which are carrying traffic much heavier than that for which they were designed, or which, by reason of poor design, age or injury of any kind, have a reduced margin of safety. Because of inability to renew some bridges in time for changed traffic conditions, or uncertainties as to revision work, lack of time for replacement after injury or for other reasons, it is occasionally necessary to keep in service structures which have not the usual margin of safety. The manner and frequency of the inspection necessary to safely maintain such structures must be determined separately for each individual case.

Railway bridges are of timber, masonry or metal, and occasionally of unusual design; men competent to inspect one kind are often incompetent to inspect other kinds, and it therefore may be necessary to limit an inspector to structures of a certain kind. It is sometimes desirable to have large and important or doubtful structures inspected by expert engineers.

Erection of Railway Bridges.†

There is not much uniformity in the practice of railway companies concerning the manner in which they manage the erection of bridges. Some companies whose bridges are of ordinary character and dimensions erect them with their own forces, others contract for the erection, others again erect the small bridges with their own forces and contract for the larger bridges.

The erection of a bridge, whether done by the railway forces or by a contractor or by a combination of the two, embraces the use of erection plant, materials and labor required for performing a number of items of work. When done by company's forces, the company furnishes all materials and plant and the separate items are distributed among the gangs properly equipped for the different characters of work, and no question arises as to what is included in the erection. When done by contract, the railways in some instances construct spur tracks, unload and store materials, furnish free transportation and engine or work train service, flagmen and falsework, maintain traffic, frame and place ties. Other companies furnish none of these items.

It is necessary to construct spur tracks for the convenient handling of materials only when the structure is of some magnitude and is at a considerable distance from the nearest siding; or when the traffic is so heavy as to require erection with the least possible interference, in which case the structure is usually erected on the outside and pulled into position. While the construction of spur tracks is at times a necessary part of the erection, the railway forces are better equipped for such work than are the contractor's, and it is therefore advisable for the company to construct them with its own forces.

†This appendix was prepared by the Chairman of the Committee, Mr. J. E. Greiner, Consulting Engineer, Baltimore, Md. It was accompanied by proposed specifications covering railway bridge erection work.

Cars cannot always be permitted to remain for any considerable length of time on sidings. They should therefore be promptly unloaded and, if the material for the superstructure has been delivered in advance of the completion of the masonry, or when it is not expedient to start the erection immediately after the delivery of the material, the material should be unloaded and the cars released by the company's forces. It cannot be expected that the contractors will ship plant and men to unload the cars and then either wait until the masonry is finished or else move their forces away.

The materials used in the erection of a bridge are usually shipped to the nearest siding, unless a spur track has been constructed at the site. This siding may be at a distance from the bridge site, and in that case will require engine and work train service in order to get materials within handling distance of the erector's outfit. The railway company will furnish such service when required. It is optional whether it will furnish all such service free of charge to the contractor, free for a limited number of days, or charge for every day's service furnished. Whether the work is done by the railway forces or by contract, there will be expense to the railway company, and it should be charged to the bridge.

When all such service is furnished free of cost, there is a possibility of abuse and calling for engines and work trains more than is necessary for the work. When each day's service is charged against the work, such service will be called for only when absolutely necessary, but in all cases of work train service there is involved more or less delay in furnishing the service on account of keeping the main tracks open for regular traffic service, and it frequently happens that but one or two hours' actual service is obtained during the day. A contractor cannot well include the cost of such interrupted service in his estimate, and thinks he has good cause for complaint when he is delayed and charged fully.

In order to avoid the abuse of engine service by contractors, a number of railways furnish such service free of cost for a limited number of days, according to the judgment of the engineer, and charge the contractors regular service rate for all time in excess of that named. This will meet the conditions better than furnishing unlimited service free, or charging for all service, as it will have a tendency to make the contractor not call for service except when necessary, and when rendered will cause him to use it to the best advantage.

Practice also varies as to the transportation furnished by railways to contractors. Some furnish no transportation whatever for men or materials, others will transport free over their lines the contractor's equipment, materials and men. This is optional with the railway, but as it involves a question of considerable expense, the contractor doing the work should know in advance whether or not he is to have free transportation. When such transportation is furnished, it is usually with certain restrictions as to trains and time.

While erection is in progress, flagmen must be stationed each way from the bridge in order to protect the trains and the work. These men should be familiar with train movements and should preferably be employees of the railway and under its complete control. Some roads furnish such flagmen and charge their wages to the contractors. The contractors understand this in advance, and add the cost of such labor to their contract price. It makes no difference so far as the cost of the work is concerned whether the railway furnishes them free of cost or charges their time to the contractors, provided the contractors know in advance who is to pay the bill.

It is not necessary for a structure intended for temporary use to be designed with the same degree of strength and excellence that would be required should the structure be intended for permanent use. It must be of ample strength for the purpose and sufficiently substantial to prevent excessive motion. In designing such structures, therefore, it is proper to take into consideration their temporary use, that traffic, if any, will be operated at slow speed, and that the structures are under constant supervision until finally removed. Materials must be suitable for the purpose, although they need not necessarily be new nor inspected with such refinement as would be applied to a structure that was to remain in service eight or ten years. It is well to properly proportion all parts for the maximum loads which will come upon them while in service, but it is not necessary to apply in these designs the unit stresses recommended for permanent regular service conditions.

Specifications for erection do not usually specify the permissible unit stresses, this matter being left either to the judgment of the erector or to the engineer who plans the work. It is advisable to fix a limit to these stresses and with suitable materials this limit could reasonably be placed 50% in excess of limits given in the Association's "Manual of Recommended Practice."

In the construction of such falsework, there can be no reasonable objection to the use of round timbers instead of square timbers for the legs of bents, provided such timbers are of sufficient dimensions not to exceed permissible stresses, and provided they are sawed off square to the axis of the stick.

When there is temporary falsework under an old bridge, placed by the railway for the purpose of supporting it until it can be renewed, the contractor who erects the new bridge should be permitted to use any part of this falsework during the construction of the new bridge, provided, of course, it is not wasted in cutting.

Some railway engineers, even when they contract for the erection of a bridge, prefer to build the supporting structure for maintaining traffic, the contractor building only such additional temporary structures as may be necessary for the handling of the work. Frequently these temporary structures, whose only purpose is to maintain traffic, are constructed without any consideration whatever as to the requirements during erection, with the result that they have to be altered, cut down, or lengthened before erection can proceed. If the railways insist upon doing this work with their own forces, the contractor's men will work at a disadvantage or lounge about waiting for the railway forces to finish.

From the writer's observation, he is not at all convinced that the railway forces are able to maintain traffic on falsework any safer or better than is done by the contractors' forces under efficient supervision, and, aside from this, when the two forces work on the same job at the same time, there is bound to be more or less interference and friction.

If the railways build the temporary structure for carrying the traffic, the contractor is relieved of that responsibility, which means that the company should always keep a force of men there to make the changes as the work progresses. In case the erection of a bridge is contracted for, it is evidently better to have the erector build the temporary structure for maintaining the traffic as well as that for erection purposes solely, in which case he is the responsible party, and on proper supervision by the railway company the work will be just as well done and interference of forces will be avoided.

When, however, railways insist upon maintaining the traffic with their own forces, the falsework should be placed so that it can be used for erection purposes as well as for maintenance purposes, and in such a manner as to interfere as little as possible with the work of the contractor.

The committee has recommended that the floor decks in all cases be placed by the railway forces. The work should be well and accurately done in accordance with well-developed plans. Many ties have been spoiled by improper dapping on account of uncertainty of the requirements shown on undeveloped plans. The railway forces are just as liable to make such errors as are contractors' forces. If the contractors' forces are required to maintain traffic, it would appear better that they should also be required to frame and place the ties, as placing of these ties is necessarily a part of the maintenance of traffic, and if in any change of the old structure to the new structure, the railway forces are not available or are not on the ground, there will be delay in the execution of the work, or the contractor will have to put all ties in for his own protection.

In the case of solid floors where ballast is used, traffic must be carried on temporary stringers during the erection of the work. When the ballasting is done by the company's forces, as is customary, these stringers should be furnished and removed by them in order not to hold the contractor at the site after all his work has been finished.

Many railways require that a special paint be used on their structures. As the paint applied after erection is a part of the material which enters into the permanent construction, it should be furnished either by the manufacturer of the steel work or by the railway, and the application alone left to the erector. Bridge erectors usually do not make a very good job of painting. For this reason a number of roads prefer to paint with their own forces, but, if the erection is done by contract, it is necessary for the contractors to know whether or not they are to do this work.

The question of responsibility during the construction of a piece of work could perhaps be more properly covered in the contract, but as the specifications form a part of the contract and are the governing rules for the execution of the work in the hands of the erector, it is well to define the contractor's responsibility in order that the man doing the work may know where he stands.

When erection work is done by the company's forces alone the question of responsibility does not arise. When done by the manufacturer or by an independent contractor, there is in all justice a division of the responsibility between the railway and the contractor. The contractor should undoubtedly be held responsible for all accidents, loss or damage to his own work, his materials or his plant, due to any cause whatever. As the company's materials are in his hands, he should also be responsible for it in case of accidents, due to causes within his reasonable control. It is proper for him to carry insurance against injury to workmen, and protect the company in case suit is entered. It is not fair, however, to make him responsible for damage to the company's property or materials when such damage is

due to causes beyond his reasonable control, as this is a matter against which he could not protect himself. The mere fact that he had charge of the company's property at the time of such accident is no reason why he should pay such costs.

There should be no material difference in the requirements of specifications, whether the work is done by the company's forces, by contractors or by a combination of the two, since rules governing the proper execution of work are just as necessary for the company's forces as for the contractor's forces, and the work should be of ample strength and of workmanship suitable for the purpose, no matter who does it.

Telephone Inspection Service in Wisconsin.

[Contributed.]

In order to ascertain the quality of telephone service afforded by the various exchanges in Wisconsin, and also to obtain a definite idea as to what might be considered "adequate service," an investigation was made of 25 telephone exchanges in the largest 18 cities of the state. This investigation was conducted by the engineering department of the Railroad Commission, which commission has the regulation of service of these utilities in charge. The tests are particularly noteworthy in that they are the most comprehensive series yet undertaken by any commission, extending as they do over an entire state.

The investigation was conducted during the months of October and November, 1909. An inspector equipped with a double-hand, split-second, stop watch, visited the 18 cities in turn, testing in secret the service at each exchange. The method pursued is outlined in what follows.

A total of 112 calls was made on each exchange visited, it being the intention to eliminate 12 of these calls later on—in the hope of securing 100 calls on each exchange which would be truly comparative. The time of response of central and subscriber were taken by the stop watch; the moment the receiver was lifted from the hook or the moment the crank was turned, the watch was started. The instant central responded and asked "Number," the first hand was stopped, and the instant the called subscriber answered the other hand of the watch was stopped. This gave the time of response by central and by party to the fraction of a second. Other points were also noted in the service; (1) the percentage of "wrong number" calls, (2) the percentage of "busy" and "don't answer" reports and the time required by central to report same, (3) the percentage of calls answered within any given number of seconds, and (4) the amount of supervision to calls given by the operator. Out of each 112 calls made, 12 were made from pay stations in order to ascertain the quality of service afforded to those using this class of equipment. The results of these test, embracing 2,800 calls, are shown in the accompanying table. The "Kalamazoo" test, results of which are shown at the bottom of the table, are included for comparative purposes. This test was an "inside test"; that is, conducted inside the exchange, and for this reason the time of response would be noted as somewhat shorter than an outside test would show, due to line delays, etc. The Kalamazoo test was made in 1903 on the Kalamazoo, Mich., exchange by the American Telephone and Telegraph Co., and the data includes 4,000 calls extending over a period of two months, during which time the operators became somewhat more skilled than usual.

From the results derived from the series of tests it was noted that the character of service afforded by the various exchanges varied through wide limits. The time required by central to answer calls was twice as long in some exchanges as in others. The quickest average response by any one exchange was 3.17 seconds and five exchanges answered all calls on an average in less than 4.0 seconds. The slowest time of answer by central for the average of any one exchange was 7.3 seconds. The average speed of the 24 manual exchanges tested was 4.78 seconds, and the average of the twelve fastest was 4.0 seconds.

It was noted from the data taken during the test that in general the best service was given at those exchanges whose operators were very prompt in answering calls. This fact was also verified by the inspector's opinion of the service. The prompt operators were more alert in practically all matters of service than were those operators who required considerably more time to answer the subscriber's calls. In the exchanges where the operators were quite prompt in responding to calls, it was noted that there were in general fewer "wrong number," "busy" and "don't answer" reports; "busy" and "don't answer" reports were more quickly made; the called subscriber was obtained in shorter time; better supervision was exercised over calls; operators were more courteous and business-like and, all in all, the degree of promptness on the part of the operators in the main gave quite directly the quality of service afforded. Therefore, the "Promptness of Operators in Answering Calls" seemed to be the most important point in telephone service—transmission, equipment, etc, being equal. It is also a feature of the service which may be readily tested and standardized.

SUMMARY OF TESTS MADE DURING OCTOBER AND NOVEMBER, 1909, COVERING 25 EXCHANGES IN THE LARGEST 18 CITIES IN WISCONSIN BY THE JOINT ENGINEERING DEPARTMENT OF THE WISCONSIN TAX AND RAILROAD COMMISSIONS.

Exchange.	Kind of system.	Total aver. time in secs — To get Central.	To get Subscriber.	Central from pay station.	% of calls answered in 5 secs. or less.	Reported busy — Av. time.	Per cent.	Subscriber Don't answer* — Av. time.	Per cent.	Given wrong No. per ct.	Supervisory signals, per cent.
1	Central energy	5.29	29	5.7	68	23.7	2.7	92	12.5	5.4	12 8
2	" "	4.52	25	4.6	77	19.6	4.5	68	17.8	1 8	3:6
3	" "	7.30	26	10.6	53	14.0	5.4	68	19.0	1.8	1.8
4	" "	4.51	26	4.0	79	13.1	7.1	68	15.0	1.8	11.5
5	" "	5.14	24	None tested	74	10.3	9.8	60	19.0	4.5	6 2
6	" "	3.17	20	2.5	95	7.8	3.6	67	11.0	0.9	8.0
7	" "	4.41	24	7.3	80	11.8	3.6	72	18.8	3 6	23.0
8	" "	4.44	24	4.5	82	12.0	7.1	71	12.5	1.8	6.2
9	" "	3 99	23	3.7	84	10.6	6 2	60	9.8	1.8	14.0
10	" "	4 54	22	None tested	81	8.8	6.2	60	9 8	4.5	4.5
11	" "	3.33	22	3.3	89	10.6	4.5	60	6.2	1.8	10.6
12	" "	3 33	19	None tested	96	7.0	5.4	74	12.5	2.7	6.2
13	" "	4.49	22	5.9	77	11.1	9.8	64	18.8	1.8	9.8
14	" "	4.89	24	9.1	86	11.4	8.0	71	12.5	0.0	12.5
15	" "	4.52	21	4.4	79	10.0	5.4	62	7.1	2.7	6.2
16	Magneto	4.72	25	4.5	79	8.8	3.6	68	23.0	2.7	9.8
17	Central energy	3.68	24	3.3	89	12.4	4.5	63	13.5	4.5	9.0
18	" "	4.92	21	8.3	74	10.8	4.5	66	13.5	1.8	9.8
19	" "	5.23	25	5.6	66	9.8	5.4	69	27.0	1.8	19.0
20	" "	5.77	27	5.4	60	24.0	2.7	52	18.8	3.6	6.2
21	Automatic	About 6 secs.	20	19.9	Automatic	9.7	5.4	70	20.0	0.0	Automatic
22	Magneto	5.69	26	6.7	60	13.4	6.2	85	22.3	0.9	8.0
23	"	5.76	26	5.1	66	16.0	4.5	94	13.5	5.4	3.6
24	"	6.93	25	9.2	49	14.6	6.2	79	25.0	0.9	2.7
25	Central energy	4.16	22	6.1	86	10.7	6.2	59	15.0	4.5	10.6
Average of the "Wis. 1909 Test" (2,800 observations		4.78	23.8	5.0	76.2	12.0	5.5	69	†16.1	2.5	8.6
Average of the "Kalamazoo Test" (4,000 observations		‡4.00	‡20.5	Not given	§80.8	‡10.0	10.5	‡67	4.0	1.2	Not given

*The high percentage in this column is due to the fact that calls were listed as "don't answer" calls in all cases except "busy" calls; where inspector was unable to get party. In all cases no call was discontinued before 60 secs.

‡As the Kalamazoo test was an "inside test," these averages should be raised from 0.75 to 1.0 seconds for proper comparison with the preceding figures.

§This figure probably would have been 80% if an "outside test" had been conducted.

Lowering of Ground-Water Level by City Water-Supplies of Indiana.*

By CHARLES BROSSMANN.†

That there is a lowering of the ground-water-supplies in this state is self-evident to any one who is able to make comparisons between present conditions and those of a number of years back. Many have advanced the theory that the receding of the ground water has been caused by the cutting down of our forests, and have stated that in the destruction of these wooded lands the rainfall is affected and consequently decreased.

The writer was under the impression at first that this was probably the case, but on further investigation has modified his opinion. It cannot be attributed to this as the records of the Weather Bureau for ten or twenty years back show that the amount of rainfall has not decreased. While the destruction or thinning out of wooded lands may to some extent be a factor in allowing a rapid run-off to surface waters, I believe that this side of the question has been largely magnified. To what then can the decrease be attributed? It seems foolish to blame it on the forest destruction, as in numerous places where the water was considerably nearer the surface ten years ago there were at that time no forests.

But a point not to be lost sight of is that when many of these plants were started, and the water was near the ground level, these plants did not create a heavy demand upon the water-supply. Many of these towns have since expanded in area and increased in population, manufacturing plants have sprung up within their confines, sewer systems have been installed thereby increasing the consumption of water in that particular place. It may be, the wells are located in the town or very close to it, and all the streets have been paved, and a good sewer system installed. No doubt a great deal of the water that originally found its way to the well is now quickly conveyed away from the town into the nearest water course.

I am of the belief that the drainage of farmlands has more to do with the rapid run-off than has the destruction of forests. There is no reason why cultivated land growing various grains, corn, etc., should not help retain as much water or almost as much as the ordinary woodland. But the water is drained from the ground to the nearest stream as quickly as possible. The writer has seen farms drained, underlying which was a splendid stratum of gravel ordinarily taking care of the greater portion of water. Whether or not it is better to get so much water away from such land as quickly as possible, I am unable to say, not being versed in the art of farming, but I am of the opinion that the drainage of farmlands is an important factor, if not the chief cause in the reduction and the lowering of the underground water-supplies.

I do not believe that all the underground supplies are lowering, but a number of them are and continue to do so, and these warrant some steps being taken to see what can be done toward preserving what we already have, that conditions may not get worse.

Herewith are given a few instances showing the lowering of the water level at various points:

Town.	Drop.
Kentland	48 ft. in 5 years
Elwood	40 ft. in 10 years
Greensburg	40 ft. in 10 years
Muncie	28 ft. in (time not given)
Remington	8 ft. in 10 years
Marion	6 ft. in 20 years. (The cause of the fall at Marion is given as waste from other wells.)
Butler	4 ft. in 10 years
Bourbon	3 ft. in 8½ years
Linton	Some wells show 30 ft. drop in 6 years.
Kokomo	Some of the wells have dropped 15 ft. since 1895.

Another point to be considered is the fact that a number of these wells showing a marked decrease are located at points where there has been a large increase in population, undoubtedly causing a greater drain upon the well. At the same time, there are other wells from which the consumption has been about the same as when started, and some of these have shown a marked decrease. However, information from a number of the plants shows that the wells still continue to give as good a supply as when first put in, and that the management notice no decrease or lowering of the water level.

IMPROVEMENTS OF THE WATER-SUPPLY of Montreal are to be studied, it is expected, by the recently organized Board of Control of that city. The Board has been granted an appropriation of $15,000, we understand, to make studies of the filtration system, high pressure water service for the business districts, and an underground conduit system—presumably for electrical wires.

*Condensed from a portion of a paper on the Public Water Supplies of Indiana, read before the Indiana Sanitary & Water Supply Association, Feb. 25, 1910.

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ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.
220 BROADWAY, NEW YORK

BRANCH OFFICES
CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
RUDOLPH MOSSE, BERLIN AND HAMBURG, GERMANY
Z. P. MARUYA & CO., Ltd., TOKYO, JAPAN

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Entered at the New York Post-Office as Second-Class Matter.

Probably the most surprising thing to American engineers in the account of the Paris floods given on another page of this issue is not the extent of this latest inundation, but rather the frequency with which floods nearly approaching this one have occurred in the past. Those on this side of the ocean who were interested in the floods from an engineering standpoint, and who were unacquainted with the hydrology of the Seine, certainly gathered from the contemporary press reports that the high water of January and February of this year was quite unprecedented and surely not to be expected from previous records. Now, however, we learn that at least six times within the last half century has the Seine reached a point not so high, to be sure, as it reached last month, but quite high enough to flood large areas adjacent to the river. With this history in mind, it would seem that the Parisian engineers have left their riparian structures somewhat open to possible damage.

Large areas of the city lie below the elevation reached by these floods, and are protected therefrom only by the quay walls. In spite of this there have been left numerous openings in these walls through which the rising water poured to the destruction of the streets and buildings. These openings were of three kinds—the arches in the Paris-Orleans railway tunnel, the abandoned sewers and the excess-flow discharge pipe at the Clichy pumping station. All three of these served as passageways through which the waters of the Seine backed up into the low-lying parts of the city. That measures of protection could have been taken to avoid this is quite evident. A check valve could have been put on at the Clichy reservoir, the abandoned sewer openings were of small use and could easily have been closed, and the openings in the Orleans Railway tunnel, while possibly helping the ventilation and lighting of that road, certainly were not absolutely necessary to its operation.

The floods of 1910 reached almost unprecedented heights and finally overtopped the quay walls which were well above all flood records of the past two centuries, but the greatest portion of the damage was not done by this crest of the flood, but occurred when the waters reached the lower levels of the quay openings some days before the crest appeared at Paris. Undoubtedly the damage to the city would have been great even had these openings been closed, but the period of flood would have been shorter and the extent of the flooded area much less.

Another lesson from the floods is that the ordinary subway structure as it is built in Paris is not waterproof against any considerable pressure. The Metropolitain and the Nord-Sud subways both filled with water to a dangerous height before the floods reached points where they gained direct access to the tunnels. This same phenomenon was observed in the basements of many buildings, particularly in those so near the river that the water had a chance to exert its pressure without intervening percolation. To what extent these walls were waterproofed we have no record, so it is useless to compare them with similar structures in this country, but it is apparent that in any porous ground subject to possible flood or raised ground water level, some extra protection must be made against percolation.

The notable water-power development in connection with the Los Angeles Aqueduct, described elsewhere in this issue, raises the question why so few municipalities utilize available water-power in connection with gravity water-supplies. The possibilities of developing large water-powers were discussed, if we remember rightly in connection with the Wachusett Dam of the Metropolitan Water-Works (Boston and Vicinity) and also in connection with the new Catskill supply for New York City, but nothing came of the discussion in either case.

The fact seems to be that most American cities find it difficult to get the necessary legislative authority to construct water-works without complicating the matter by proposing power development also. Most cities know too well, or would soon learn, that propositions for electric-power plants would meet with strenuous opposition from various private companies which wish to keep the electric light and power service entirely to themselves. With the march of events we shall see fewer and fewer water-powers unutilized for no better reasons than that the development by a city would curtail the business of some company. If the voters at Los Angeles approve the proposed hydro-electric bond issue on April 19, as is confidently expected, other cities will be encouraged to improve similar opportunities—although few, indeed, have such a notable chance to develop electrical power as has Los Angeles.

Seattle led the way in municipal electric-power development in connection with public water-supplies in the Far West, although to a considerable extent the Cedar River hydro-electric plant is independent of the water-supply of Seattle. San Francisco proposes to create large amounts of electric power as a part of its Tuolumne River water-supply, but most or all of that power, we understand, will be required to force the water over a mountain in the path of the water-supply conduits.

It would be a thousand pities if New York City should further reduce the inadequate space around its city hall and dwarf that gem of early American architecture by carrying out the present plan of building an immense, overtowering court-house in the city hall park, directly in the rear of the city hall. Such a course would seem strange, indeed, at a time when the cities of the country, great and small, are vying with each other in the creation of ample, dignified and beautiful civic centers.

Instead of a new and larger court-house on and around the site of the building that made Tweed infamous the old court-house and the old brownstone building alongside it should be removed.

We venture to go further and express the hope that some day the general post-office will be torn down, and thus at one and the same time the city hall park be restored in its entirety, a view of the city hall be given from a number of blocks farther down Broadway, and the city be relieved of a pile of stonework which, to say the least, is architecturally unworthy of either the metropolis or the country.

The clearing of the post-office site is not so chimerical as might at first appear, for the federal government was given title to the site by the city under agreement that the site should revert to the city if the government should give up its use for post-office purposes.

If the new court-house is kept out of the city hall park and the present one removed, the day may not be far distant when the national government will provide a worthy general post-office building elsewhere. Ten years hence the nation will have had free ground rent in the city hall park for half a century. That ought to be sufficient, under the circumstances, especially in view of the fact that the new Hudson Terminal Building, the new Pennsylvania station and tunnels and other transportation changes in New York City are rapidly altering the conditions under which mail is being received and distributed.

We briefly commented in our last issue on the Raldiris bill, now pending in the New York Legislature, requiring the licensing of civil engineers. The title of the bill ought to be amended so as to read, "A bill to strangle the engineering profession with red tape." The bill is now in the hands of the Assembly Committee on Education, the chairman of which is Mr. Fred. C. Filley, of Albany. An engineer who attended the hearing on the bill held by the committee on March 17, writes to us urging that engineers should make themselves heard at Albany in opposition to the bill, or there is danger that it will be reported and passed.

It is stated that the bill is proposed and backed by the "Technical League," an organization having headquarters in the Park Row Building, New York City. It is of interest, therefore, to note that one clause of the bill gives the penalties which may be collected under the bill for practising without a license or transgressing any other of its many requirements, to any incorporated engineering society making the complaint on which the prosecution is based.

As we pointed out last week, the bill places the control of engineering practice in the state of New York in the hands of the Board of Regents of New York University. This is a body, which, in our opinion, is now exercising a most pernicious influence, through its authority over the educational system of New York State. But that is another story. The point of interest to the engineering profession is that this body of men would have the ultimate control, without appeal, of admission to practice in the engineering profession. The bill provides, moreover, that in order to receive a license to practice engineering, a person "must have studied engineering not less than four school years, including four satisfactory courses of at least seven months each in four different calendar years in an engineering school registered as maintaining at the time a standard satisfactory to the Board of Regents of New York University."

We believe there are few graduates of technical schools of high standing in the profession who would not protest against the exclusion from the profession of the men who obtain their professional training in the school of experience. The technical schools themselves are not asking for legislation to give their graduates a monopoly of the profession. At the recent hearing at Albany, the Faculty of Rensselaer Polytechnic Institute presented a statement condemning the bill in strongest terms as injurious to the engineering profession.

It should be understood that this bill affects all ranks of the profession and not the engineers engaged in independent practice alone. One clause of the bill reads:

> After Aug. 1, 1911, no person not already employed, thus unlicensed by the Board of Regents, shall practice engineering or perform its subordinate duties in the capacities of rodmen, levelmen, transitmen, topographi-

cal or structural steel draftsmen, computers or engineering inspectors.

The matter of the pending bill was brought up at the meeting of the American Society of Civil Engineers on March 16, and was referred to the Board of Direction. It is to be hoped that local engineering societies in New York State may aid in defeating the measure.

The State of New York owns hundreds of thousands of acres of land in the Adirondacks and the Catskills which constitute the State Forest Preserve. These lands have been acquired at great expense, ostensibly for the benefit of the people of the state. Owing to constitutional restrictions, the Forest Preserve is of but little use to the citizens of New York compared with what it might be. The restrictions absolutely prohibit any forestry work of any kind, thus preventing improvement cuttings, or even the removal and sale of dead and fallen timber. No roads can be cut to make the forests accessible and no forest lands can be flooded for the storage of water for power purposes, city supply, or river regulation. All these and other restrictions are contained in the following clause of the State Constitution, inserted at the last general revision of that instrument, in 1894:

[Article VII., Sec. 7.] The lands of the state, now owned or hereafter acquired, constituting the forest preserve as now fixed by law, shall be *forever kept as wild forest lands* [italics ours.—Ed.]. They shall not be leased, sold or exchanged, or taken by any corporation, public or private, *nor shall the timber thereon be sold, removed* or *destroyed* [italics ours.—Ed.]

The reason for inserting in the Constitution so sweeping a provision, equally effective against the State itself and all private persons, is generally understood to have been the fear that by no other means could protection be secured against stealing timber and diverting the use of portions of the Forest Preserve to purposes other than public pleasure and recreation.

Whatever may have been the original reasons for this prohibition, conditions to-day are such as to demand a more intelligent administration and use of these vast tracts of Adriondack and Catskill lands. They should at least be made accessible by State roads; there is no good reason why dead and dying trees should not be removed, sold, and the revenue therefrom used for the administration or extension of the Forest Preserve; and there are excellent and sufficient reasons for permitting the use of small portions of these lands for water storage. It may be explained that several of the proposed State water-storage projects and one or more of the proposed main lines of State highways are barred because a small fraction of the reservoirs would flood a few acres of these State lands and because some of the roads would extend through the Preserve, involving, in each case, some destruction of timber.

To remove these absurd restrictions, which serve to shut out the body of the people from use or benefit of the very lands supposed to be dedicated to them forever, steps have been taken to amend the Constitution, by twice passing and then referring to popular vote a concurrent resolution of the State Legislature. This resolution provides that the section of the Constitution which we have already cited

shall not prevent the use of lands in the forest preserve, or the timber thereon, for the following purposes:

1. Lands in the forest preserve may be used for the storage of water and the development of water-power and the transmission of electric current under State control, and for that purpose the legislature may authorize the use of land for the erection and maintenance of dams, the impounding of water and all other improvements thereon necessary and incidental to such purposes, provided, however, that the quantity of land so used shall never exceed 3% of the total area of the forest preserve.
2. Lands in the forest preserve may be used for the construction of highways by and at the expense of the State.
3. The Forest, Fish and Game Commissioner, with the approval of the Governor, may lease for periods not longer than ten years sites of not more than five acres for camps within the forest preserve.
4. The Forest, Fish and Game Commissioner may remove and dispose of dead and down timber in the forest preserve.
5. The Forest, Fish and Game Commissioner may, with the approval of the Governor, sell and convey lands now owned or hereafter acquired by the State, which are situated wholly outside the boundaries of the Adirondack and Catskill parks, as now defined by law, and the proceeds from lands so sold and conveyed shall only be used by the State in acquiring lands situated wholly within the boundaries of said parks.

The resolution providing for the amendment just cited has been introduced in the Assembly by Mr. Edwin Merritt, Jr., Chairman of the Ways and Means Committee. A hearing on the proposed amendment will be held at Albany on March 29.

All who are interested in a national conservation and utilization of forests and streams of New York State would render a service by giving their attention to this proposed amendment, and by expressing their opinions upon it, either in person at the hearing or in letters to the representatives at Albany.

In the main, the provisions of the amendment seem wise, but possibly they need further limitation at some points, particularly as regards the leasing of camp sites. They do not seem to go quite far enough in conferring authority for water storage on State lands. Sec. 4 might well be altered so as to leave no question as to the power of the State, through its State Water Supply Commission or otherwise, to build the storage reservoirs at State expense.

A proposed bureau of municipal research in connection with the University of Illinois was noted under "Notes from Engineering Schools" in our issue of March 17, 1910. The University of Illinois has already been rendering much practical assistance to municipalities through the State Water Survey. We presume it is doing other work of a similar character. The proposed bureau of municipal research certainly presents great opportunities, both for the University and for the municipalities of the state. There has been altogether too much useless duplication in the collection of information regarding comparative municipal practice; but worse yet, perhaps, has been the failure of many municipalities to take any steps whatever to profit by the experience of other cities.

In connection with an engineering investigation of the street-railway system of Milwaukee, made by the Wisconsin Railroad Commission and discussed elsewhere in this issue, studies were made of the average time required per passenger for boarding and alighting from the street cars. These studies were continued in several other cities, for comparison with conditions existing in Milwaukee.

The results of the investigations of "pay-as-you-enter" cars in St. Louis are worthy of notice.

It will be recalled that this type of car was originated, largely, to reduce the delays in boarding and alighting. But at St. Louis, when more than six people were assembled at a crossing to board one of these cars the delay per passenger was greater than with the old type. After the boarding crowd numbers ten, the delay begins to be serious on account of its rapid increase. As street railways all over the country are trying the prepayment car on a large scale, it seems worth while to discuss the reasons for the failure of the cars in this respect.

Part of the difficulty is due unquestionably to deficient platform capacity. Some of the prepayment cars now being operated have room for only three or four passengers between the farebox and the step. If the passengers could pass into the car as rapidly as they mounted the step, there would be no extra delay; but at least half the passengers as a rule have to obtain change from the conductor before depositing their fare.

From considerable observation of "pay-as-you enter" cars in different cities, we are strongly of the opinion that a ticket system is essential with these cars to obtain the best results. Once induce passengers to buy tickets, as is the custom in Washington and in Montreal, instead of paying fare with nickels, and delays to take on passengers need be no greater with pay-as-you-enter cars than with the ordinary type.

We are aware that street railway managers raise the objection that to sell tickets at a reduction means cutting down their revenues; but it must not be forgotten that the reduced revenue per passenger is partially offset by the greater number of passengers. The ticket system does stimulate riding, and even a slight reduction of fare by the ticket system encourages the use of the cars by short-trip riders, t class most profitable to the railway company.

Moreover, cutting down delays in boardi cars means increased car mileage, and th means that a given amount of rolling stock a employees will do more work at less expen It helps net earnings to cut down expenses much as to increase revenue. It has recent been officially stated that every reduction of half mile per hour in the average speed of t cars on the Metropolitan Street Railway lin in New York City means a loss of half a millio dollars a year in the company's net receipts. T repeat what we have already expressed in the columns: If American street railway manage had adopted three-cent fares and the ticket sy tem fifteen years ago instead of extending t transfer privilege, they would to-day be in f better financial condition and the public wou have been better served and better satisfied.

President Taft last week at the Chicago Con servation Congress took strong ground in favo of the protection of the public's interest in th mineral lands of the West. Secretary Ballinge at the Minnesota Conservation Congress about the same time sneered at the "doctrinaires" who were figuring out a short life for the coal deposits, intimated that there was coal enough to last for 7,000 years, and declared that the public lands of the West "must still be used to promote development." The contrast between the attitude of the President and that of the Secretary of the Interior was striking.

Mr. Ballinger has been certified to be a true friend of the Conservation movement; but judging him by his published utterances, his friendship appears to resemble the friendship of Joab for Amasa. Joab said to Amasa, "Art thou in health, my brother?" and took Amasa by the beard to kiss him. At the same time he smote Amasa with a knife under the fifth rib that he died.

The Inland Waterways Propaganda in France.

One of the stock arguments of the waterway promoters in this country, an argument which has done duty for at least a dozen years, is the development of waterways in France and Germany. "See," says the waterway promoter, "here are the principal industrial nations of Europe spending many millions of dollars to build canals and improve rivers. If those nations deem it wise to develop water transportation on a huge scale, ought we not to follow their example?"

This argument, however, assumes that the waterways policy of the European nations has been adopted and carried out on the advice of experts in engineering and transportation. It is of interest, therefore, to inquire how the waterway development of Europe has actually been brought about. It is of especial interest to find that in France, Government expenditure on waterways is being urged on by organizations similar to our American waterway associations, while the Government engineers are extremely conservative in their views on water transportation.

Of course it is well understood that the conditions in France are far more favorable to water transport than in the United States. The rivers and canals were well developed as routes of freight traffic before the railway was dreamed of. Nevertheless, the competitive struggle between the boat and the railway train has resulted there as here in the decline of waterway traffic on the minor routes.

A few canals and canalized rivers have continued to prove economically valuable as transportation ways and as such have been maintained in a fair state of efficiency, but the great majority of smaller waterways have lost much of their business as a result of railway competition.

For many years the French government has been carrying on the improvement of the rivers and canals of the republic under plans prepared by the Government engineers.

There are two of these official plans, that of 1879 and that of 1903, but the latter is largely

an amendment of the former. Under the former project of 1879 it was intended to spend eventually 400,000,000 francs ($80,000,000), but up to the end of 1909 only 268,000,000 fr. ($53,600,000) had been used and the appropriations were being granted at a very slow rate, the amount for 1909, for instance, being only 8,000,000 fr. ($1,600,000). At that rate it will be seen that the entire project could not be completed until about 1920, about 40 years after its inception.

This progress was not fast enough for the enthusiastic; and an organized effort was made to influence the government to inaugurate more extensive work upon canal and river improvement. This popular agitation has been gradually increasing, just as it has in this country; and along all the rivers where there is even a remote possibility of future navigability, societies have been formed to forward the inland waterways propaganda. Concerning these local waterway societies our French contemporary, "Le Genie Civil," says:

> On all sides organizations were founded with the intention of influencing public opinion, of gaining disciples to their ideas and of forcing the Government to consent to improvements which they had in view and from which they awaited untold riches. Many of these associations, "La Loire Navigable," the "Sud-Ouest Navigable," the "Office des Transports du Sud-Est," etc., have a long history. Others have been formed only recently, such, for instance as the "Association Francaise pour L'Amélioration et la Defense de la Navigation Interieur."

One of these societies, "La Société la Loire Navigable," bears such a resemblance to some of our American associations that a glance at its history is of interest. It was founded in 1893 at Nantes, on the lower Loire River, following a vigorous campaign by the press. It had for its object the promotion of official projects to improve the lower Loire River, particularly between Orleans and the ocean. In 1896 it had founded branches at six towns along the river. In a convention held that year at Nantes it declared in favor of a through channel down the river from Orleans to Nantes and decided to engage in a huge press and publicity campaign to achieve that end. Several weeks later, through powerful influence brought to bear on the Ministry of Public Works, it obtained a government appropriation of $2,000 to make preliminary investigations of the scheme.

Since that time, the association has held a number of conventions in cities along the valley and has never ceased pushing the project, through the press, and by petitions, conferences, the publication of a monthly bulletin and by participation in the various expositions in France. As a result of all these endeavors a government investigating committee was appointed and a small section of experimental canal was built, but the possibility of the construction advocated by this industrious society being carried out is very remote, as the scheme was finally condemned by the Ponts et Chaussees committee referred to below.

This association is typical of a number of similar societies which have flourished in France, each with similar intentions for its own particular locality and each pursuing practically the same course of procedure. In some few instances the associations grew beyond the restricted local interests and took up the promotion of the general waterway movement, but as a rule each was merely after a slice out of the "pork barrel" for its own pet scheme.

All of this agitation, however, finally had some effect on the government.

In April, 1908, the Minister of Public Works addressed a letter to the "Conseil General des Ponts et Chaussees," the leading governmental engineering body, requesting that it make a thorough investigation of the present status of inland navigation in France and the possible and desirable future improvements in it.

In the Autumn of 1909 the "Conseil General" brought in its report, and at the time of its publication the French technical press devoted considerable space to the discussion of the whole question of inland navigation.

In many respects the problem in France is entirely different from that in this country. The restricted area of the country and the government ownership of the railways there, are two items alone that give to the problem a quite different aspect.

The report of the government engineers divided all the proposed schemes for waterway improvement into four classes. The first-class includes the schemes which are so extravagant that they may at once be laid aside as unworthy of serious consideration. At the other extreme are the projects which should be adopted for construction at an early date. Next come projects which may be taken up after those of the first class are completed and third are projects which may some day be feasible; but can await consideration until the more promising schemes are completed.

The report was made only after the most complete study conducted by the experts of the department from both an economic and an engineering standpoint. The results are entirely unprejudiced; the government ownership of the railways and the regulation of railway rates to prevent undue competition with the canals makes impossible the stock argument in the United States that waterways are necessary to regulate railway rates.

The details of the report are unimportant in so far as they apply to specific projects. In general a quietus was put on practically all of the as yet incomplete schemes projected in 1879. The schemes for a canal from the Mediterranean to the Atlantic was dismissed and the much agitated Paris-to-the-sea canal condemned as impracticable. Thus, some of the dearest schemes of the inland waterways agitators were shelved. The through-Europe canal was conceded to be possible, if arrangements could be made with the other countries so as to ensure uniformity of lock and prism dimensions, but such an agreement seems out of the question at present and so the scheme is placed in the possible but not desirable class. Only one new canal is proposed for immediate construction; all of the remainder of the immediate appropriations should be applied to the improvement of present ports and rivers. The tabulated list of the program is as follows:

	Total.	By Government.
Immediate projects.....	$47,800,000	$29,200,000
Secondary projects.....	13,400,000	12,200,000
Possible future projects....	79,200,000	53,200,000

From this table it will be noted that according to the proposition of the "Conseil General" the government will bear only a part of the expense of the work and that the rest of the expense will be provided from other sources. According to the proposed budget it will take between 15 and 20 years to carry out the schemes listed above as "immediate projects," so that the time of the construction of the others will, of necessity, be very remote. In approving the $140,000,000 worth of work projected above, the "Conseil General" rejected proposed schemes totaling $330,000,000 additional.

It must be remembered that this report is from a body not unlike our Inland Waterways Commission (except that it is made up of expert engineers instead of Congressmen), and that its findings have no authority but only can be taken as advice. The proper governmental authority has, as yet, made no appropriation other than in regular continuation of the old project of 1879.

The evident conclusion from the above is that in France, as in the United States, waterway schemes and huge appropriations for them are being furthered by popular agitation based on fallacious ideas of the economic status of water transportations, while the weight of conservative engineering opinion seeks to save the nation from spending money on schemes without warrant in sound engineering and economics.

The attitude of French engineers is, perhaps, fairly indicated in the following freely translated from our Paris contemporary "Le Genie Civil":

> During the last few years we have been subjected to a propagandist movement in favor of the rehabilitation of the inland waterways of France. As the result of the constant hammering, the public has become vitally interested in the question, Parliament has taken it up and studied it, and the Minister of Public Works himself has been so worried that he has been forced to ascertain with what confidence he could regard the protestations coming to him from all sides. To this end he called in the "Conseil General des Ponts et Chaussees" experts to decide the question for him.
>
> As a result of this expert investigation it can now be said that the agitation is beyond reasonable bounds, for the "Conseil" has summarily thrown out most of the schemes proposed by the extreme waterways advocates. In new waterways, except the "Canal du Nord-Est" and, at some distant time, the lateral canal along the Loire, no project found favor. The most grandiose and popular schemes—Paris-to-the-Sea, the Rhone lateral canal, etc.—are finally condemned. Nearly 2 billions of francs of proposed work has been thrown out as impracticable; out of a total of 146,000,000 fr. judged practicable, 71,000,000 fr. is to be devoted to improvements, and 75,000,000 for new construction.
>
> This courageous decision will please all those who have any regard for the proper utilization of public funds.

LETTERS TO THE EDITOR.

Bonding Plaster Coatings to Concrete Interior Walls and Ceilings.

Sir: With reference to inquiry in your issue of March 3, 1910, p. 256, regarding the "difficulty in treating concrete surfaces left by wooden forms, so as to secure a good key for interior plastering on walls and ceilings": Do not treat them; have the surfaces clean, not wet but slightly damp. Treat the mortar by gaging each hod with one scoopful (about one quart) of plaster of paris. This will be about right for a mortar made by mixing one barrel of Portland cement to the cubic yard of lime mortar, or ordinary lime mortar. This method will answer equally well for walls coated with damp-proofing.

Respectfully,
Emmet A. Steece,
M. Am. Soc. C. E.

Fayetteville, Ark., March 7, 1910.

Sir: I take notice of an inquiry in the issue of your paper for March 3, 1910, p. 256, in reference to "bonding plaster coatings to concrete interior walls and ceilings." I believe the inquiry is well worthy of consideration, and amounts to more than is suggested by editorial note.

There are thousands of buildings throughout the country where concrete floors form the ceiling for the story below, and also where the columns, and in some cases the side walls, are of concrete, and it has been a serious proposition with many builders to determine as to how these concrete surfaces may be plastered so as to insure against plaster peeling off. There have been hundreds, and probably thousands of cases, where the buildings have been turned over to the owners with the plastering apparently in good condition, and where at a later date the plaster has peeled off of the ceilings, and in some cases the columns and walls, leaving the bare concrete slabs exposed with the appearance that the plaster never in the slightest manner adhered to the concrete. Yet there are other buildings plastered apparently under the same conditions where there is no trouble.

I notice that in specifications of late date for Federal Buildings, the attention of the contractor is called to the necessity for some treatment of the concrete, so as to insure the adhesion of the plaster onto the concrete surfaces, but they give us no idea of what this treatment shall consist or how the required results may be accomplished.

It is my opinion that the difficulty is not because of a smooth and slick surface on the concrete slab which prevents the plaster from adhering to it, as is often supposed to be the case, but that the trouble comes from plastering the concrete when it is not entirely dry, or more likely caused by the slab getting wet from working on floors above after plaster has been put on. The dampness in the concrete then causes efflorescence on the surface and forces the plaster away from the concrete, or as is likely in most cases, this efflorescence is already on the surface of the concrete and in plastering over the same, no adhesion is secured, because of the dusty surface which prevents such adhesion.

No doubt the same difficulty is to some extent often the result of dust and smoke settling onto the concrete before the plaster is applied.

It is my idea that if the concrete is not plastered until it is fairly well dried out, then kept dry, the surface thoroughly brushed with a wire brush, and then washed off with water, not more than half a day in advance of applying the plaster, and then the first coat of plaster put on very rich and thin, that there will ordinarily be no difficulty about securing proper adhesion. I believe that it is advisable to put on the first coat of plaster much richer than an ordinary mixture, possibly using finished coat instead of ordinary brown coat for the same.

This proposition is well worthy of careful investigation, and I trust that your paper may secure the views of other parties who have had experience in reference to it.

Respectfully,
C. L. Bartlett

Cedar Rapids, Iowa, March 9, 1910.

Sir: Answering the inquiry of Mr. Hall, I will say that if cinder concrete is used, in general no difficulty will be experienced. If, however, a gravel or broken stone concrete is used, where the aggregate is very small and the mixture is made rich, considerable difficulty will often be experienced in getting the plaster to stick—particularly if dressed lumber is used for forms and the concrete is mixed very wet.

In cases like this, the writer has sprinkled coarse cinders on the forms about ½-in. thick. After the centering is removed, these cinders are brushed out with an old broom or wire brush. This will be found much more effective and also cheaper than going over the surface with a chisel and hammer.

Very truly yours,
C. W. J. Neville.

New Orleans, La., March 14, 1910.

The Design of Electrodes for Electric Furnaces.

Sir: Your report of the papers read at the meeting of the American Electrochemical Society last October (in your issue of Nov. 4, 1909, p. 499) reflected the impression which one, who did not follow electric furnace work closely, would naturally receive from an academic discussion of such an involved engineering problem as the design of electrodes for furnaces. Much stress was laid by theorists on the supposedly great importance of certain correction factors which were acknowledged in the paper to exist but were thought to be small. None of these critics, however, did, or could, give any actual figures showing that the corrections were really seriously large.

Since this report was published, the question of the relative importance of these factors has been investigated by abler physicists than the critics were, and has been shown by them to be negligibly small. Hence the simple laws of the proportions and thermal actions in furnace electrodes deduced and enunciated for the first time in that paper, can be relied upon for most if not all engineering calculations. Their rigid correctness under the assumed approximate premises has not been and cannot be denied by any one.

The above is shown in the complete discussion which has just been published in Vol. 16 of the Transactions of the American Electrochemical Society, p. 297. That all these correction factors are eliminated very effectively, and in a very simple manner, by using the complete analysis described in that paper, is shown in a later one, on a recent series of experimental investigations entitled "Proportioning of Electrodes for Furnaces," printed in the March, 1910, issue of the Proceedings of the American Institute of Electrical Engineers and to be read at the Charlotte meeting, March 30-April 1.

Briefly, some of the chief results of the writer's extended investigation, both analytical and experimental, are as follows: (1) Our former rules for proportioning furnace electrodes were, in part, actually wrong, in part, inadequate and, in part, misleading. The current density for instance is unquestionably not a determining factor; the resistance is not a matter of choice but is determined by the specifications; the length and section are not both determined quantities, as there is a choice left of either one or the other, because it is only their ratio which is fixed by the specified data. (2) The total loss is not the sum of the thermal conduction and the electric losses but is the sum of the thermal conduction (when no current is flowing) plus only half of the C^2R loss. (3) The thermal and electrical conductivities are neither of them alone determining factors as heretofore supposed; the real physical qualities which determine the electrodes are the quotient and the product of these two conductivities. The former fixes the loss and the latter the size. (4) Moreover, the experimental constants, determined apparently for the first time as a series of values in the writer's investigations, show that in these values also, our former figures (what there was of them) were in part considerably in error, in one important case (carbon) even in the sign! Some of the above results are mathematically true only under the simplest conditions, but it has been shown that they are sufficiently correct for all engineering calculations even under the most complicated conditions.

The general result of the whole investigation, as far as it concerns the engineer who designs furnaces, is that, by abandoning all our former rules and tabulating from experimental tests certain new quantities for the different temperature ranges, the calculations of the sizes and losses reduce to simple multiplications, hence are the acme of simplicity. These two new quantities are (1) the "watts per ampere" which when multiplied by the current needed for the furnace, give the minimum loss in watts, and (2) the "sectional area per ampere per inch length" which, when multiplied by the current and the length (both fixed by the furnace requirements), gives the section in square inches. These two quantities are obtained directly by the writer's new method of obtaining the constants experimentally, the correctness of which method has been questioned by no one. They are based on the fundamental principle that the electrode shall not chill the furnace or unnecessarily heat the walls. The loss then is exactly a minimum when the variations of the conductivities are small enough to be neglected, and sufficiently nearly the minimum for all practical purposes, when they are not neglected. (See the very able paper of Dr. A. E. Kennelly on "Modifications in Hering's Laws of Furnace Electrodes," Proceedings of the American Institute of Electrical Engineers, March, 1910, p. 267.) The determinations of the proper proportions of electrodes is thereby reduced to a simple engineering calculation, and is no longer largely a matter of guessing.

When this complete method is used, the corrections due to the temperature variations of the conductivities, which have been the cause of so much academic discussion, are taken care of by inclusion in these experimentally determined constants which are given and explained in the papers. These criticisms have thereby been met.

The question of whether the method is "obvious," as has been claimed, is, of course, a matter of opinion. Although one of the critics has made a specialty of this subject, this "obvious" solution of the problem had never suggested itself to him before I had described it. This is shown by his own publications in which he drew conclusions directly opposite to those which would follow from the "obvious" solution; he also admitted that he did not understand one of the fundamental features of the obvious solution, and even after my paper was read, insisted that one of the chief consequences of this obvious solution was obviously wrong. Many things seem obvious after some one has taken the trouble to demonstrate their correctness.

Respectfully yours,
Carl Hering,
Consulting Electrical Engineer.

929 Chestnut St., Philadelphia, Pa., March 18, 1910.

Freight Handling by Machinery and the Proposed Chicago Union Station.

Sir: In regard to the article by Mr. Harding on terminal freight handling in your issue of March 3, I do not feel at all sure that all of the economies claimed by Mr. Harding can be realized. I do believe, however, that his plans have merit, and that where the volume of business to be handled is sufficient to give continuous employment to a large number of men such an installation would be of value.

At every place where freight is handled provision must be made for keeping accurate record of the disposition of every piece. This feature is not referred to by Mr. Harding in any of his papers and I assume therefore that he does not consider it of first importance, but to cover it properly would of course add materially to the cost of handling by his methods and require more men than he has assumed to be necessary.

Another point to be considered is the distribution of men to take care of and pack the goods into cars after being delivered by the mechanical appliances. This work is done, under present practice, to a very great extent by the truckmen and generally the truckmen are kept constantly employed. If the truckmen are eliminated their place must be taken by others so far as handling the goods is concerned; certain gangs will load the carriers and other gangs will unload them and the carrying or transporting only can be done mechanically. But the mechanical appliances cannot bring back to the transfer clerk the evidence that the goods have been properly disposed of, as is now done by the truckmen, and to do this will require that a very complete system of checking be used in connection with this method of handling.

Another disadvantage that would probably be encountered would be caused by careless loading of flatboards or carriers, and consequent loss and damage caused by goods falling off or striking obstructions in transit. There would probably also be trouble caused by careless hoisting and lowering, too rapid starting and stopping and too rapid turning at corners.

From the above you will note that it is my opinion that Mr. Harding's method will prove successful where large amounts of goods must be handled, but that the saving in cost will be only in the movement. The cost of loading the carriers will, of course, be at least as great as the cost of loading trucks. In fact trucks would have to be used in most cases to load the carriers, and this operation would have to be repeated where the goods are reloaded into cars, and the cost of checking and loading would, no doubt, be increased. The proposition therefore is that the saving in the movement must be more than enough to pay for installation and maintenance, and must also pay for the clerical service now performed by the truckmen. I believe that these results can be obtained, but would like to see an installation with Mr. Harding in charge to demonstrate the advantages claimed.

I have noted also the article on plans for union stations in Chicago, in your issue of Feb. 24, and will say that in my opinion this matter should have been attended to before so much track was elevated.

The La Salle station will probably remain, also the stations on the lake front, but these can be used for local service as proposed. With all these things considered my opinion is that the great union station should be in the vicinity of the present union station and the new Chicago & Northwestern station should have been a part of it. This location would probably be more easily accessible to all railways that enter Chicago than any other site that could now be chosen.

The principal object of course is interchange of through passengers without transfer across the city. It is also important that the location be convenient for the travel originating and terminating at Chicago. It appears to me that the site proposed would meet all requirements. That the station should be elevated, and the tracks should pass through so that reverse movements would be generally avoided.

Division Superintendent.

The Deplorable Attitude of Illinois Legislators Towards the Registration of Vital Statistics.

Sir: I have been reading with much interest the editorial note on page 169 of your issue of Feb. 10, 1910 concerning vital statistics in Illinois.

I am greatly pleased to have you call attention to this matter, as I have been trying for years to have Illinois added to the registration area.

A few days ago I had the pleasure of talking before the City Club of this city, concerning this point, and I am enclosing an abstract of my remarks on that occasion.

Very sincerely,
Geo. W. Webster,
President State Board of Health of Illinois.

70 State St., Chicago, Ill., March 7, 1910.

[We quote enough from Dr. Webster's address to show the prevailing indifference and opposition to measures necessary to accurate vital statistics in Illinois:

In 1902 I was partly instrumental in having the legislature of Illinois pass a registration law providing for the compulsory registration of all births and deaths, for immediate registration uniform with the methods of the Census, for the use of the international system of classification, and for the reporting of all births and deaths occurring in the state. That became a law. In 1902 there was a very decided sentiment against the continued operation of this law in the state of Illinois. The farmers, if there were a loss of an Alderney cow or of a blooded horse, would immediately have this recorded in the herd book, but the people of the state of Illinois decided it was too much trouble for them to obtain legal permission to bury their dead. They did not want any registration law, important as it might be—as I shall try to show you—from a public health standpoint.

Mr. Miller, the ex-speaker of the House of Representatives, was the man who led the forces that demanded the repeal of this law. The late Senator Burnett, from the southern part of the state, was another one who was interested in the repeal of the law. After making as hard a fight as we could make in the legislature, after seeing that these men had been elected on the platform that they were going to bring back the scalp of that bill, and after seeing that we were doomed to defeat, we decided to compromise. We finally compromised by having the bill practically emasculated, in that the compulsory burial permit feature was eliminated. The result is that the law is so emasculated that the Census Bureau will not accept our returns as authoritative.

The ideal after which we are striving and toward the consummation of which the Bureau of the Census is working in cooperation with the American Medical Association and the Federal Congress, is a complete, accurate, immediate, uniform registration of all births and deaths, which will place the United States on a par with other progressive nations in this respect.

In connection with this same thing, the American Public Health Association and the American Medical Association, in cooperation with Mr. Cressy L. Wilbur of the Census Bureau, drew up a model bill, shaped on the lines of the laws that have proven so adequate and satisfactory in such states as Pennsylvania, for example. They presented this bill to the different boards of health in the different states where such laws have not as yet been passed. One of these bills was drawn up and adopted by the American Medical Association and the American Public Health Association, receiving their unqualified approval. That bill was still further corrected by Mr. Wilbur to conform with the constitutional and other provisions of the state of Illinois. It was ready to be introduced in the Forty-sixth General Assembly of Illinois, but we were plainly told by the legislators to stop. We were told that we could not pass any such bill in this state, that the people were not as yet educated to the need of this thing, and did not want it. We were told that it had no immediate practical value. It was impossible for us even to secure a hearing on the law.

Such a deplorable state of affairs can be explained only on the assumption that the relation of vital statistics to public health-protective work and the importance of the letter is but little

understood in Illinois. The universities of that State, the medical and engineering professions, the State Board of Health and such local health boards as are akin to the situation might well join in a campaign of education. A few years of energetic, well-planned work would doubtless dispel the ignorance and overcome the indifference and opposition that now unite to keep the health authorities and people of the State in darkness as to their real health and sanitary conditions, as reflected by that best of all indicators, the accurate and complete statistics of mortality, classified by causes and ages, and prompt and complete returns of all cases of communicable disease.

It is surprising that the Illinois Society of Engineers and Surveyors, the Illinois Water Supply Association, and the organization devoted to protecting the waters of Lake Michigan have not taken this matter up in detail before this.—Ed.]

Notes and Queries.

The statistics of material treated by various wood preserving processes, published on p. 151 of our issue of Feb. 3 were for the year 1908 instead of 1909. The statistics for 1909 are not yet collected.

A correspondent writes us requesting information regarding the value of blast furnace slag for concrete aggregate. Following current practice we have advised him that there is danger in the use of such an aggregate unless the sulphur be thoroughly removed by storage and washing, but we have been unable to find any good experiments or records of experience which bear out this practice. If any of our readers have knowledge of any such records we think their publication would be of interest to the profession.

Improving the Street Railway Service at Milwaukee, Wis.; the Result of an Investigation by the Wisconsin Railroad Commission.

[Contributed.]

As the result of citizens' protests, the city of Milwaukee some two years complained of excessive fares and inadequate service on its street railway lines, the complaint being addressed to the Railroad Commission of Wisconsin. In February, 1907, the Commission undertook to have valued the physical property of the street railway company, and this work was done under the direction of the Commission's Engineer, Prof. W. D. Pence, who is Professor of Railway Engineering at the University of Wisconsin. The primary object of this appraisal, which occupied some six months in all, was to determine the value of the physical property for rate making purposes for the Railroad Commission, and for taxation for the Tax Commission. Later the

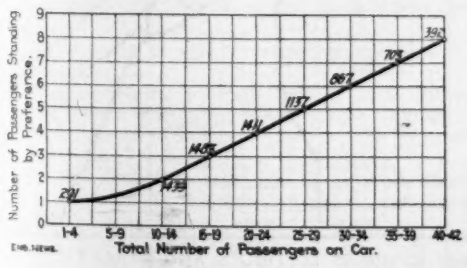

Fig. 1. Curve Showing Number of Passengers Standing (By Preference), on Milwaukee Street Cars.

(The numbers shown at the plotted points indicate the number of cars observed—each car having the total number of passengers shown below.)

question of service came up, and this was investigated as described below The matter is still pending, and no decision has as yet been reached by the Railroad Commission concerning either the rate of fare or the service. The company now sells 25 tickets for $1, or six for 25 cts. Over a year ago the city again complained concerning the service. At a hearing held by the Commission, evidence of a somewhat conflicting nature was submitted touching certain phases of the problem. This evidence was of too indefinite a character to serve the Commission's purpose in reaching an intelligent decision upon matters of a very technical nature. Therefore it was found necessary to delegate the engineering staff to undertake an independent field investigation of the service rendered by the street railway company at Milwaukee.

The field work was begun in October, 1908, and from then until March, 1909, from two to five men were kept constantly in the field making observations upon service conditions. A final report covering the investigation was made in June, 1909. This report was directed to the three chief phases of the problem: (1) the extent of service given by the company; (2) the service required by the traveling public, and (3) the necessary reroutings of the various lines in order to lessen the present congestion in the business district and to obtain better accommodations for certain classes of traffic. The investigation was made in the most thorough manner and required a time of service equivalent to that of five men for practically 4½ months.

The report presents a number of technical matters which have not heretofore been treated in such investigations. Among these points particular mention may be made of the process by which was determined the number of passengers "standing by preference," whereby the normal "comfortable load" was found for use in interpreting certain "car demand" curves. The "car demand" curves are also a noteworthy feature of the report, as the demand for cars is shown graphically for each line of the system. Another interesting and important point brought out in the investigation relates to the promptness or alacrity of passengers in boarding and leaving cars. Observations were made of this feature at Indianapolis, St. Louis, St. Paul, Minneapolis and Duluth, as well as Milwaukee. A study was first made of the traffic as a whole. After a few observations had been taken, it was noted that the times of greatest travel were 6 to 9 a. m., 11 a. m. to 2 p. m., 5 to 8 p. m., and from 10 to 11 p. m. These intervals were designated as Periods One, Two, Three, and Four. The observations were then confined mainly to the above periods of traffic, it being assumed that any scheme which would care for the traffic then would suffice. Period Four proved to be unimportant and it was neglected. The main lines of the system (14 in number) were studied in detail at each of the three periods of dense traffic. The following data were taken on each line at each point of observation and of each car going in any direction.

(1) Car line.
(2) Period.
(3) Time.
(4) Direction of car.
(5) Number of car.
(6) Total number of people on car.
(7) Number of people standing in front vestibule.
(8) Number of people standing in rear vestibule.
(9) Number of people getting off car.
(10) Number of people getting on car.
(11) Class of passengers.
(12) Condition of vehicular traffic.
(13) Condition of pedestrian traffic.

In addition to securing these data, which quite fully occupied the inspectors' time, the following general studies of each line were made.

(A) Division into characteristic sections (each bounded roughly) and discussion of class of passengers, time of travel and probable destination.

(B) Study of origin, destination and probable route of passengers (reference to factories, etc.).

(C) Noting transfer points and number (in percentage of passengers leaving car from which transfer is made) transferring to other lines (name line) in various directions.

(D) Note feeling of public served by particular line as regards service given by the company.

From a total of 9,000 cars observed, it was noted that a number of the passengers preferred to stand even when seats were available, and this tendency seemed to follow a fixed law. In fact, observations showed that in 1,499 cars an average of two people stood by preference when only 10 to 14 people were on the car; in 1,483 cars observed, three people stood when there were only 15 to 19 passengers; in 1,411 cars observed, four people stood out of each 20 to 24 riding; five were observed to stand in 1,137 cases where there were from 25 to 29 people on the car; six stood in 867 cases when the car contained 30 to 34 people. An average of seven remained standing in 705 cars observed which contained from 30 to 39 people; and finally in

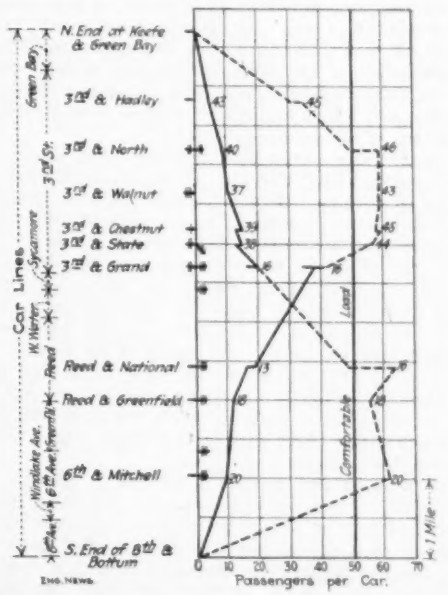

Fig. 2. Curves Showing Demand for Cars at Transfer Points; Milwaukee Street Railways.

(Period of maximum travel. Numbers at plotted points indicate observations.)

392 cases in which there were from 40 to 42 passengers on the car, 8 of these stood by preference. Therefore, for a car having a seating capacity of 42 people (the size of the street car in general use in Milwaukee) a "comfortable load" was taken as 50 passengers, on the assumption that eight people would prefer to stand even if seats were provided for them, and that it was therefore unnecessary to provide seats for these eight.

This tendency is shown graphically in Fig. 1. Several reasons have been advanced to explain why this condition should be found.

The passengers may wish to stand on the rear platform and smoke; they may prefer to stand on the front platform for observation; or they may have been sitting down all day and prefer to stand for that reason; or, having only a short distance, they may not care to go to even the slight trouble of searching for one of a number of available seats.

Having determined a "comfortable-load unit" for the car, the next question to determine was the number of cars required for the service. This was solved by observing the number of people riding during the maximum periods of travel upon each of the 14 main lines. The average number of people on the cars for these periods was plotted, and where these averages exceeded 50 people it denoted that the cars were more than "comfortably" filled. From these determinations, the extent and duration of the overcrowding readily became known, and the number of extra cars needed was readily determined.

Fig. 2 illustrates the method pursued in ascertaining the demand for cars. Inspectors observed the number of passengers at different transfer points along the route—as noted on the diagram—and the curves were then plotted as shown. The periods of greatest travel as stated were noted to be from 6 to 9 a. m., from 11 a. m. to 2 p. m., and 5 to 8 p. m. These periods were then each subdivided into a maximum sub-period, or period of greatest travel, and a minimum sub-period, or period of least travel. An average of

travel for the entire period was also computed. The vertical line shown on the diagram marks the comfortable load of 50 passengers. The jagged line shown indicates the number of passengers at the various points noted on the margin to the left. Where this line is shown dotted it applies to cars coming into the city, and, where solid, it applies to cars leaving the business center. Where these lines pass on the right side of the vertical "comfortable load" line it indicates that the car has become crowded.

These diagrams were computed for each car line and they indicated at a glance at just what periods the cars are overcrowded, and the amount and duration of this overcrowding. The destination of the passengers is also shown. By compiling all this data it was found just where, when and why additional cars were necessary on certain of the company's lines.

It was discovered that a considerable amount of overcrowding was due to the distorted headway or unequal time spacing between cars. There were several causes for this: various running speeds were observed; people in boarding or leaving would detain a car longer than was necessary; a drawbridge might be open, or the motorman himself might be careless in controlling the speed of his car so as to maintain the proper headway. The result of all this was that two cars might follow each other just a square or so apart, while from eight to ten minutes might elapse before another car came along. The first and third cars in this event might become considerably overloaded.

After each line had been studied in considerable detail in the effort to ascertain just what the requirements of the traffic were as regarded the proper number and headway of cars, the matter of the destination of passengers was then considered. The entire territory embraced by the various lines was divided into different districts, as shown in Fig. 3. A study was then made of the character of the traffic, the district served, etc. The city was divided more on the engineers' maps than can be shown here. For instance first and third class residential areas were marked and wholesale mercantile districts were distinguished from retail. In an effort to ascertain the destination of the average passenger to further aid in this consideration, a complete set of transfers for an entire day was obtained, and by going over these in connection with the "car demand curves," the origin and the destination of the average passenger on each line were determined. This was necessary in order to ascertain the rerouting necessary to thus serve the demands of the public. As an example of the results of such a study of the transfers, it was found for instance that a very considerable percentage of the morning and evening traffic in the western and northwestern part of the city of Milwaukee had a final destination in the southwestern part of the city on the other side of the Menomonee valley. It was necessary for these passengers to travel through the downtown congested district, across the Menomonee valley at West Water Street and then forced westward out along the National Avenue or some similar line. This necessitated a couple of miles unnecessary travel with the consequent loss of time which could have been saved if the traffic were routed across the valley direct at some more western point.

A large number of the car lines considered passed the important intersection at Third St., and Grand Ave. This point is the most congested part of the city, and with the teaming, pedestrian traffic, likelihood of drawbridges being open, etc., it forms a point where cars are very likely to be delayed a considerable period. To avoid this difficulty, it was proposed to reroute several of the lines in the downtown district (as shown in Fig. 3), so as to make it unnecessary to cross this intersection. This would still bring the cars to within a short distance of this point and thereby relieve the congestion.

In obtaining the headway, or time spacing between cars, to be used in the proposed rerouting, the following points were given consideration in ascertaining the minimum time spacing:

(A) The minimum practicable time interval between successive cars where there is no disturbing cause to produce delay.

(B) The delays of interruptions of any given car due to causes arising from other cars operated over the same or intersecting tracks.

(C) The delays due to causes arising within the car under consideration.

Under (A) the period was determined as 8.3 seconds in actual practice. In calculating the "safe minimum spacing" allowance was made: (1) for the space covered in one second to allow the train crew time to act; (2) for the distance required to stop the car, and (3) for a clear space of 15 ft. between cars when stopped.

Under (B) the average delay was determined as 9.09 seconds, at points where double tracks crossed double tracks with double curves in the four quadrants.

By summing up the averages obtained under (A) and (B) the average delay was found to be 17.4 seconds and this would therefore be the safe minimum headway. As the speeds used in Milwaukee were somewhat faster than those used in other cities compared, it was deemed advisable to suggest a minimum headway of 20 seconds. This would allow 180 cars per hour which may be operated past a given point in one direction.

This safe minimum headway corresponds to that derived by Mr. George Weston, Board of Supervising Engineers, Chicago (Wis. R. R. Co Report, Vol. 1, p. 674), who testified:

"The minimum practical headway that can be oper ted upon a fairly busy street with cars making t ordinary service stops and running at maximum spe of from 6 to 8 miles per hour (in the congested distric is 20 seconds."

Another point covered in the investigation w the movement of passengers in alighting fro and boarding the cars. It was noted that passe gers in Milwaukee were slow compared with t average passenger in other cities. From obse vations made in St. Louis, St. Paul, Minneapol

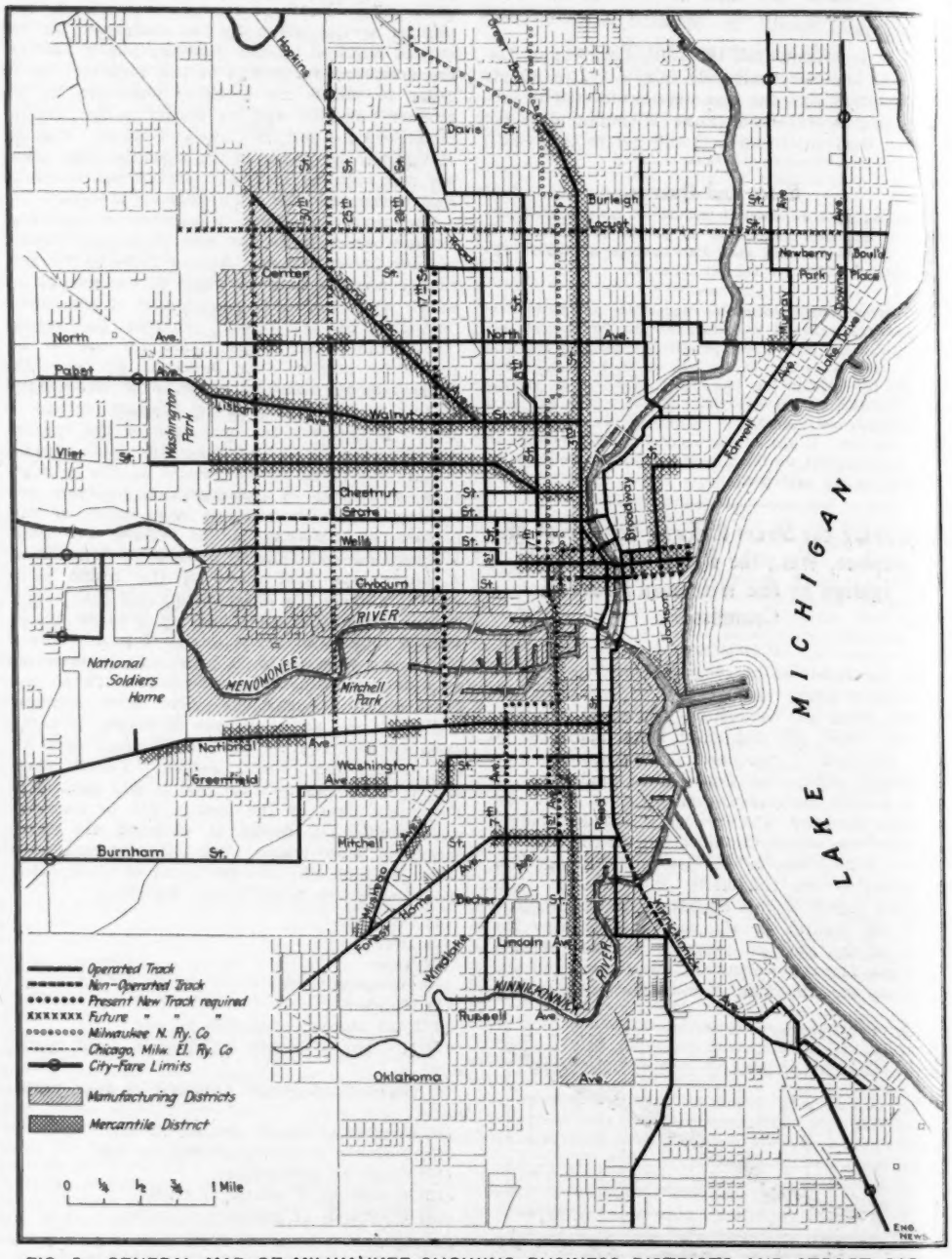

FIG. 3. GENERAL MAP OF MILWAUKEE SHOWING BUSINESS DISTRICTS AND STREET CAR LINES.

Duluth and Indianapolis, as well as in Milwaukee, it was determined that during the evening peak in the downtown districts of these cities, it required on an average of 1.5 seconds per passenger in Milwaukee to board a car when ten passengers were getting on. This contrasted with 1.37 seconds in Duluth and St. Louis, 1.25 seconds in Minneapolis, 1.20 seconds in St. Louis and St. Paul, and 1.02 seconds in Indianapolis. When five people boarded a car, the average in Milwaukee was also longer than that of any other city. At Indianapolis five people would board a car in an average of 1.25 seconds per passenger, while at Milwaukee 2.12 seconds were required. And even when 15 passengers were to board, there was considerable difference in the time required by the average passenger between

Milwaukee and the other cities investigated. As a matter of fact, the best time made at Milwaukee was approximately 1.20 seconds per passenger, no matter how large the crowd, while the other cities attained an average of approximately 0.8 seconds per passenger when from 15 to 20 people or even more boarded the car. In a general way, this same feature was noted in the movement of passengers in leaving cars. All this is shown in Fig. 4.

At the first glance it would appear that this slowness was due entirely to the passengers themselves, but upon investigation it was ascertained that the company was partly to blame, due to their having no definite established stopping places for their cars. For instance, a car might stop exactly on the far side of a crossing, while the car following might stop a car length or so past this point. The people would generally congregate at a certain place, expecting to board the car there, and when the car proceeded 30 or 40 ft., past this point it was necessary for them to walk or run to it. This caused considerably more time for boarding than would otherwise be the case.

On completion of the engineering studies, the following suggestions were made to the company for the improvement of their service:

(1) Adopting certain rerouting schemes.

(2) Providing a sufficient number of cars to take care of the traffic on the various lines which were overcrowded at periods shown.

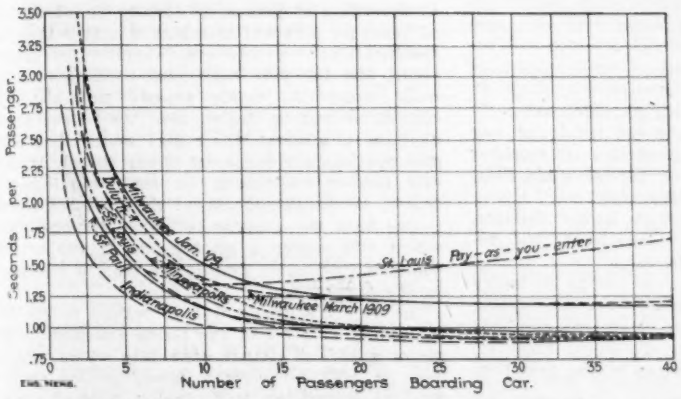

FIG. 4. CURVES SHOWING BOARDING MOVEMENTS ON STREET CARS IN BUSINESS DISTRICTS OF SEVERAL CITIES.

(3) Establishing definite stopping places at street intersections suitable for all conditions of travel.

(4) Making service stops on both sides of important transfer points.

(5) Soliciting the cooperation of the public through the medium of proper signs posted in the car.

(6) Exacting greater courtesy on the part of train men.

(7) Endeavoring to train the public to move on and off cars in a more systematic manner.

(8) Better supervision of cars at the various street railway intersections.

(9) Requiring the trainmen to be more alert in saving time at intersections and to act more promptly upon the supervisor's orders.

(10) Insisting that trainmen do not shirk by running their car so that the one ahead or the one behind will receive the passengers.

(11) Using more care in maintaining proper headway or time spacing between cars.

The commission also suggested that the public could assist in improving the service by more readily complying with the requests of the conductors, by filling the car body and relieving the congestion of aisles and vestibules as far as possible and by being more prompt in leaving and boarding the cars.

Copies of the report were submitted to the interested parties on completion of the investigation and before publication of the results.

Since the report was submitted the street railway company has ordered 100 additional cars to be delivered this spring. The city has granted the company franchises on certain streets in order to facilitate the traffic. One of the most important concessions being permission to operate cars across the Sixteenth St. viaduct. This will obviate the necessity of carrying passengers, living in the western and north-western part, down through the business district in order that they may reach the southwestern part of the city. This will effect a considerable saving in time by affording a direct route through the western part of Milwaukee. A more systematic directing of passengers, by signs and polite requests, is being undertaken, and definite stopping places for the cars at street crossings, have been established.

The report, together with the physical valuation of the street railway property as made by the engineering department of the Railroad Commission in 1907, should form a basis for reaching a conclusion as to the final disposition of the present controversy between the City of Milwaukee and the street railway company, and should eventually result in greatly improved street car service to that city.

Annual Convention of the American Railway Engineering and Maintenance-of-Way Association.

The eleventh annual meeting was held March 15 to 17 at the Congress Hotel, Chicago, with an attendance of about 360 members. As usual the program was very long, with reports from 20 committees, but only a few of the reports were given any extended discussion. The main discussions were on steel rails and the economics of railway location. There were seven business sessions, and the only entertainment was the annual dinner. President Taft paid the convention a visit in the afternoon of March 17 and made a short address in which he remarked that this country is behind other countries in laws regarding trespassing on railways, and he pointed out that better laws of this kind were needed for the protection of the railways and the people.

The convention opened with the address by the President, Mr. Wm. McNab (Grand Trunk Ry.), who referred to the development in both railway construction and reconstruction improvement, and also to the development of new transcontinental routes. The reports of the secretary and treasurer showed a membership of 869, and a financial statement as follows: receipts, $19,758; expenditures, $21,203; balance in hand, $16,403. The officers for the present year are as follows: President, L. C. Fritch, Chief Engineer of the Chicago Great Western Ry.; Vice-Presidents, W. C. Cushing, Chief Engineer of Maintenance of Way of the Pennsylvania Lines (Southwest System), and C. S. Churchill, Chief Engineer of the Norfolk & Western Ry.; Treasurer, C. F. Loweth, Engineer and Superintendent of Bridges and Buildings of the Chicago, Milwaukee & St. Paul Ry.; Secretary, E. H. Fritch, 962 Monadnock Block, Chicago.

The following is a brief review of the reports and the proceedings. Several of the reports are noted more fully on other pages of this issue. Only three committee failed to make reports: (1) uniform general contract forms, (2) fuels and structural materials (cooperating with the national advisory board), (3) brine droppings from refrigerator cars.

Roadway.

The principal feature of this report was a valuable compilation of information regarding practice in regard to the cross-section, lining, drainage and grades of tunnels. We shall give an abstract of this in a later issue. A good part of the discussion related to the amount of grade reduction to be given in tunnels. The committee recommended that the grade should be 25% less than the ruling grade, and Mr. Churchill (N. & W. Ry.) thought it should be "at least" 25%. Mr. Brooke (B. & O. Ry.) stated that as the result of experience his road now extends the grade reduction upon the approach below the tunnel. This matter will be considered further by the committee, in connection also with the question of ventilation. The clearance of 22 ft. above head of rail was changed to 22½ ft. above base of rail.

Ballast.

This report recommended a maximum size of 2½ ins. for stone ballast (instead of 2 ins. as at present), the minimum size remaining at ¾-in. The returns from individual roads indicate a preference for the smaller sizes (2½ ins. maximum) when the material is such that it will drain well, as the track is more easily surfaced and kept in surface than when stone larger than 2½ ins. is used. The size to be specified should be determined by the quality and character of the rock selected. As to gravel ballast, the committee recommended that for lines of heavy traffic, bank gravel containing more than 20% of dust or 40% of sand should be washed or screened, and that it should then contain not less than 25% or more than 35% of sand. For lines of medium traffic, the limiting proportions would be 30% or 60% in the first case, and from 25% to 50% in the second case.

Attention was called to the physical tests of crushed stone which are made by the Office of Public Roads (U. S. Department of Agriculture). These were designed to test stone for highways, but are satisfactory also for testing stone for ballast. One feature of these, brought out in the discussion, was that they do not include any test for crushing strength, the department stating that it "never has been able to discern any relation between the crushing strength of rock and its behavior in a road surface." The report recommended that stone ballast should be cleaned at intervals of 1 to 3 years in terminals, 3 to 5 years on lines with heavy traffic (especially coal and coke), and 5 to 8 years on lines of light traffic. When this is done, from 15 to 25% of new ballast should be applied.

Ties.

The report recommends the more general use of the association's standard forms for results of tie renewals, although some of the replies to the committee's inquiry indicate that these are too elaborate to allow of reliable information being given, especially as they call for this detailed information from each track section. The section foremen are hardly competent to keep the necessary records, and the result is that they are compiled largely by guess. It has been suggested that individual sections be taken as representative of entire divisions, or that test sections be selected in different parts of the country, so that careful attention might then be concentrated on these sections. However, as stated, the committee believes that valuable statistics and information would result from the general use of the present blank form, but intimates that in future its work will be confined to such railways or officers as are interested in the matter. That this will simplify its proceedings is indicated by the fact that only 45 replies were received to 700 circular letters containing enquiries as to this matter of tie records. This is another proof of the waste of energy and money involved in seeking information by sending out such inquiries broadcast.

The committee's recommendations were adopted: (1) favoring the continued use of the present form of records, and (2) advocating the cultivation of trees as a basis of future tie supply. The report contained some information as to tree planting on different railways, the results of treated ties laid in an experimental section of track in Texas, and some information as to certain steel and concrete ties. This last matter supplemented a former report which was abstracted in our issue of Sept. 30, 1909.

A paper on "The Conservation of Ties by Means of Protection from Mechanical Wear" was

read by Mr. J. W. Kendrick (A., T. & S. F. Ry.), outlining the problem of timber supply and consumption. To ensure the economical use of wooden ties the following steps were recommended: (1) treat the ties with some preservative to prevent decay; (2) use metal tie-plates of sufficient area and thickness to properly distribute the maximum pressure from the rail to the surface of the tie; (3) use screw spikes, and make the square head (for the wrench) with sides vertical instead of inclined; (4) use hollow plugs or dowels of treated wood screwed into the ties to receive the screw spikes. Steel and concrete ties were considered as offering very few advantages. The paper was illustrated by a number of lantern slides. It came at the end of a long evening session, and owing to the lateness of the hour there was no discussion.

Wood Preservation.

This report presented revised specifications for coal-tar creosote and for the treatment of ties by several processes: zinc-chloride, zinc-tannin, zinc-creosote (both emulsion and two-injection treatment), and plain creosote. These specifications were adopted. The appendices included (1) the strength of treated timbers, (2) a list of 71 wood preserving plants, (3) a report on the service of ties treated by various processes and laid on a line in Texas in 1902, (4) the physical structure of wood in relation to its penetration by preservative fluids, (5) the grouping of ties for experimental preservative treatment, and (6) the fungi of structural timbers.

Conservation of Timber Supplies.

The special committee cooperating with the National Conservation Commission has held no meetings since the previous convention, but submitted a brief report of progress accompanied by suggestions prepared by the secretary of the commission as to methods by which railways may assist in the conservation of natural resources. These are in brief as follows: (1) control of forest fires; (2) growing timber for railway purposes; (3) use of sawed instead of hewed ties, as the latter involve the waste of about 70% of the tree; (4) the use of treated timber. The report was presented by Mr. Burpee (Bangor & Aroostook Ry.), and was accepted without discussion.

Rails.

The committee set forth very plainly the responsibilities of the rail makers for the continued unsatisfactory quality of modern rails, and pointed out that railways have not been able to purchase rails according to specifications satisfactory to them. This matter we have noted elsewhere. No change in rail sections is recommended, but the delivery of bad-quality rails of the section proposed by the American Railway Association shows that the quality of the rail does not depend upon the section. A revised form of specifications was submitted, based upon conferences with the manufacturers, and covering both Bessemer and open-hearth steel. Separate bulletins issued by the committee have recorded statistics of rail failures and an astonishingly bad character of many modern rails which have broken in service.

This report was one of the few to receive any extended discussion. In presenting it, Mr. C. S. Churchill (N. & W. Ry.) referred to the poor quality of some of the rails rolled to the new heavy-base section of the American Railway Association. He stated also, that in preparing the specifications the committee has taken the position that the quality of the rail should be determined by establishing tests of the finished product rather than by prescribing details of manufacture. Some members spoke of finding the chemical analysis of the general run of rails very different from that of the test ingot, and it was suggested that the specifications should provide some limits for the rails. Mr. Churchill and others replied that they had found very little trouble of this kind, and that it was impossible to stop the mills to take analyses of individual rails. The railways can make such tests later, and in some cases the mills have taken back rails found in this way to be defective. One member, however, remarked that the rails are likely to be in the track before the makers' tests are checked; experience has shown also that with care in manufacture the rails from various heats can be made to conform very closely to the test ingot. There is, of course, an allowable variation, since no two rails from the same ingot will show exactly the same analysis, but he insisted that the specifications ought to include limits to this variation.

On motion of Mr. Webster (Consulting Engineer), this matter of additional requirements as to the chemical composition of the finished rails was referred to the committee for consideration. The same action was taken in regard to a reference to "injurious" defects and flaws, some speakers considering this term likely to cause trouble between the railways, the rail inspectors and the mills.

The necessity of adjusting the drop tests to exclude soft rails of too high a deflection as well as hard and brittle rails of too low a deflection was suggested by Mr. Sullivan (Can. Pac. Ry.), and Mr. Churchill explained that this is being considered by the committee. More definite requirements for the careful loading of rails at the mills were suggested also, and Mr. Trimble (P., Ft. W. & C. Ry.) remarked that where mills use loading devices there is little trouble in this respect. Mr. Webster suggested that the requirements should provide also for care in unloading by the railway. Mr. Atwood (P. & L. G. Ry.) stated that the committee has made arrangements with some mills for the manufacture of certain rails (of both Bessemer and open-hearth steel) which will be subjected to a special series of tests under the direction of Mr. Max Wickhorst (C., B. & Q. Ry.): (1) chemical tests, (2) physical tests, (3) wearing or abrasion tests in the revolving machine of the Pennsylvania Steel Co., (4) crushing tests in a special machine of the Maryland Steel Co., (5) track tests, (6) service tests.

As to the tables and diagrams of rail failures, Mr. Cushing (Penn. Lines) considered that reliable comparisons cannot be made as to the respective values of high and low carbon or heavy and light base, owing to insufficient information as to the roadbed and traffic conditions, methods of manufacture, etc. They do show, however, that most of the failures occur in the first four years of the rail's life.

Track.

This committee had a brief report, with specifications for frogs and recommendations as to certain details of track work. It specifically recommended tie-plates of the shoulder type, which give a bearing to the outer edge of the rail base. Its recommendation was adopted that track on tangents need not be re-gaged when it is not more than ½-in. out of gage, provided that the increase is uniform. Some of the members thought this allowance for wide gage was much too high.

Signs, Fences and Crossings.

This committee presented revised specifications for fences; also recommendations as to protection against snow and the proper construction of road crossings. It stated that investigations are being continued as to the corrosion of wire fencing, and that several railways are experimenting with a new form of woven wire fence which is galvanized after weaving. The committee speaks favorably also of concrete fence posts, several forms of which were described in its report last year (Engineering News, March 25, 1909).

Iron and Steel Structures.

This committee presented a revision of its specifications for steel bridges, the changes being pointed out by Mr. Greiner (Consulting Engineer) in presenting the report. These were approved with little discussion. The instructions as to bridge inspection were adopted, as was a statement concerning the relative merits of steel and reinforced concrete for short span bridges. The committee recommended 40 ft. as the limit for concrete slabs and girders. A draft of proposed specifications governing the erection of railway bridges was (by request of the committee) referred back for further consideration. One of the appendices to the report was a review of the development of metal bridge building in America by C. L. Crandall. For the subcommittte on impact tests, Prof. Turneaure (Univ. of Wis.) presented a progress report. This was accepted with the recommendation that further tests include (1) long spans, (2) very short spans, (3) concrete slab spans, and (4) secondary stresses. A progress report of the subcommittee on the allowable length of flat spots on car wheels was presented also. There was very little discussion on any of these matters.

Wooden Bridges and Trestles.

This report contained revised specifications for two grades of southern yellow-pine, as adopted in 1909 by the Yellow Pine Manufacturers' Association. It called attention to the importance of careful inspection in order to make the specifications of real significance, and of rejecting material which does not come up to the specification on which material is purchased. The report contained also specifications for Douglas fir and western hemlock. In these last, the "standard heart grade" is intended for general use in bridges and trestles, while the "standard grade" is intended for falsework, trestles for filling, and for other temporary construction. White Douglas fir is excluded in the standard heart grade and accepted in the standard grade since it is not regarded as sufficiently durable for use in other than temporary structures.

The committee concluded that while it may not be necessary at present to specify the percentage of heart for different members of a structure, the specifications are intended to stand for several years, and the time may come soon when heart wood cannot be easily secured and the percentage should be designated. As to the specifications in general, the report states that some specifications are too strict in certain particulars, and timber conforming to their requirements cannot be purchased except at excessive prices. It has been the purpose to frame a specification which will secure a good grade of timber and which is thoroughly practicable from a manufacturer's standpoint.

The only discussion was in regard to the acceptability of some of the terms assigned to different grades of timber, especially where "standard" is used for certain second-quality timber. For the committee, Prof. Jacoby (Cornell Univ.) objected to any change being made by the convention, as the specifications are uniform with those accepted by the yellow-pine manufacturers and the American Society for Testing Materials. No action was taken therefore, but Mr. Fritch (C. G. W. Ry.) suggested that the matter should be taken up with the other associations in order to arrive at terms which are less confusing.

Masonry.

The committee submitted revised specifications for natural and Portland cement and for plain and reinforced concrete, together with instructions as to the design of reinforced-concrete structures. The specifications for concrete class the material as fine aggregate and coarse aggregate, instead of stone, gravel and sand. The specifications for structural steel reinforcement require an ultimate tensile strength of 60,000 lbs. Mr. McDonald (N., C. & St. L. Ry.) thought this was too high, for commercial reasons. He ordered material recently under a similar requirement, but had to accept 55,000-lb. material, the other being unobtainable.

A subcommittee presented a progress report on the waterproofing of masonry and stated that there is a very live interest in the subject. It included several statements of individual practice and experience and presented the following deductions: (1) failures are due to two causes, (A) faulty details, such as flashing along webs of girders and around corners and angles of steel work, (B) the formation of cracks from any cause; (2) for any system of waterproofing to be successful, the concrete must be reinforced to prevent temperature and shrinkage cracks.

Specifications for Cement.

This special committee recommended certain changes in the specifications, to bring them in line with those of the American Society for Test-

ing Materials. It recommended also that the subject be assigned to the Committee on Masonry (as was formerly done), and that the special committee be dismissed. The report was presented by Mr. Kelly (Grand Trunk Ry.), and was accepted without discussion.

Buildings.

This committee presented general information on the subject of roof coverings, and designs for section tool houses. It reported that the use of reinforced concrete for coaling stations and storage bins is increasing, and that their cost averages about 50% greater than that of timber structures of the same capacity. The designs and specifications for tool houses were attacked from every point of view; design, construction and location. It was decided to adopt only the general design and dimensions, the specifications to be considered by the committee for its next report.

Water Service.

This committee submitted specifications for railway water tanks and towers of both wood and steel construction, with tanks of 50,000 and 100,000 gals. capacity; also for steel stand-pipes. A subcommittee had an extended report on friction factors for pipe lines and water columns, including diagrams of loss of head, and a paper by Prof. A. N. Talbot on experiments on water columns made at the hydraulic laboratory of the University of Illinois. The committee recommended flat hoops for wooden tanks, as it found that round and half-round bars are very little used. Two or three members spoke of the failure of flat steel hoops, and Mr. Stein (C. Ry. N. J.) has substituted round bars in such cases, while Mr. Courtenay (L. & N. Ry.) stated that he had adopted round bars in preference to flat bars, and Mr. Loweth (C. M. & St. P. Ry.) has adopted round bars as standard. There was some criticism as to the steel specifications, and eventually the report was referred back to the committee for revision.

Signals and Interlocking.

This committee presented a majority and a minority report, the former signed by 18 members (representing seven railway systems and four manufacturers) and the latter by four members (representing four railway systems). The majority report submitted, and recommended for adoption, a comprehensive scheme of indications adapted to a uniform system of signaling. The minority report set forth that the proposed scheme was open to serious objection on a number of points, and should not be adopted without further consideration. The discussion related entirely to the method of disposing of the reports, and not to their subject matter. The chairman of the committee, Mr. Rudd (Penn. Ry.), read a long reply to the minority report, and rather assumed the attitude of an irreconcilable, arguing that it would be useless to refer the reports back to the committee with the idea of having the differences adjusted. The vice-chairman, Mr. Clausen (C., M. & St. P. Ry.), pointed out that the scheme proposed had been submitted to the Railway Signal Association for adoption and had been defeated by a large majority on a letter ballot. He thought there was no doubt that further consideration would result in a report which all the committee would approve.

Mr. Mann (Mo. Pac. Ry.) and Mr. Rhea (Gen. Elec. Co.) pointed out that the signaling question has two distinct features: (1) engineering, and (2) operating. The system of indications to be adopted is a matter of operating, but the committee has been carrying on its work without any authoritative outline from the operating side of the service as to what the indications should be. This is a matter which lies with the American Railway Association. If that association will decide upon the indications to be given, the committee can then proceed with a better understanding and with a better prospect of its recommendations being approved by both associations. On motion of Mr. Hunter McDonald (N., C. & St. L. Ry.) the reports were referred back to the committee, with instructions to confer with a similar committee of the American Railway Association, with a view to harmonizing the opposing opinions in a report to be presented at the next meeting.

Yards and Terminals.

This committee has formerly dealt only with the design and operation of freight yards and terminals, and the handling of freight by machinery. Its report this year, however, dealt with passenger terminals, and as it has only commenced its work in this direction no conclusions or recommendations were presented. It submitted, however, (1) a revision of its former recommendations regarding freight yards and terminals; (2) some additional information on freight handling by machinery (with mention of the Harding proposed transfer system described in our issue of March 3), and (3) information as to the track plan, traffic and operation of 26 passenger terminal stations. There was little discussion.

Records and Accounts.

This committee had been instructed to revise the system of forms for maintenance-of-way records, as previously presented, but the report stated that it had not been able to complete this work, for the following reason:

> The great difficulty that confronts the study and consideration of forms is the variety of organization on existing railways. There are three general classes of organization as far as maintenance-of-way is concerned, which differ materially and which often require different forms to serve the same purpose. These may be outlined as: (1) The large railway organization which is departmental in character; (2) the large railway organization which is divisional in character; (3) the small railway organization which is a composite of both departmental and divisional.

The subcommittee on conventional signs for drawings submitted some revisions, as letters received from many engineers have indicated a general opinion that the signs are too numerous and in many cases too complicated, involving loss of time in the drafting room. Other subcommittees presented forms of estimates for bridge work and water service work.

Rules and Organization.

The work of this committee during the year had been confined to a revision of its general rules for the government of employees of the Maintenance-of-way, signal and bridge-and-building departments. There was very little discussion. Mr. Rose (C., C. C. & St. L. Ry.) suggested that the rule requiring track-walking to be done daily should be modified to exempt "roads of light traffic." Other members thought that safety requires this daily inspection whether the traffic is light or heavy. The committee, however, decided to change the rule by adding "except when specified otherwise." Thus the section foreman has general instructions to do the work daily unless he has specific instructions to the contrary.

Economics of Railway Location.

This committee had prepared a valuable report discussing the questions of power and resistance, and presenting conclusions which will form a basis for a method of estimating the relative economic values of different locations. We shall deal with this report later. In the discussion, Mr. Fritch (C. G. W. Ry.) suggested that in many cases where traffic is comparatively light money has been spent unnecessarily in grade reductions, whereas under such conditions it would be more economical to purchase more powerful engines to handle the trains. It was pointed out also that the weight of evidence indicates that there is little variation in train resistance due to speed, at least within a range of from 10 to 35 miles per hour. With the steam locomotive, however, the full capacity cannot be maintained continuously at the higher speeds, and herein lies one of the advantages of electric locomotives for freight service. For equalizing resistance on tangents and curves a grade compensation of 0.035% per degree of curve was recommended by the committee. This was sustained after some discussion in which both 0.04% and 0.03% were suggested as substitutes, while one member suggested that for a freight line (having its curves elevated for low speeds) a compensation of 0.025% would be sufficient.

A curious feature of the report was in recommending that the superelevation on curves should be gained by lowering the inner rail and raising the outer rail. This may have theoretical advantages, but it has the great practical disadvantage of leaving the section foreman with no basis for checking and maintaining his curves; it also introduces a low spot in the track, which is always an objectionable feature. The almost invariable practice is to maintain the inner rail at grade and to put all the elevation in the outer rail. The Louisville & Nashville Ry. maintains the high rail at grade and lowers the inner rail, but this practice is very exceptional. Mr. Shurtleff (C., R. I. & P Ry.), on the part of the committee, stated that the Rock Island and the Union Pacific use the plan advocated in the report, but he admitted that this was in construction only, and he could not say how it was followed in maintenance. Mr. Lum (Southern Ry.) thought it safe to say that investigation would show that the section foremen are keeping the inner rail at grade and putting all the elevation in the outer rail. In fact, he did not see how it would be possible to do otherwise under conditions of track maintenance work. Mr. Porter (Bess. & L. E. Ry.) called attention to the number of vertical curves introduced in both rails by the arrangement proposed. When put to the vote, the committee's recommendation was eliminated from the report.

Electricity.

A progress report of this committee, which has to do with electric traction and the electrification of steam railways, was presented by Mr. Austin (L. I. Ry.). It has considered the report of the American Railway Association's committee on the location of third-rail conductors and is of opinion that the clearance between the rail and the equipment should be greater than the 1½-in. clearance recommended in that report. There was no discussion.

The Performance of the Turbine Steamers "Mauretania" and "Lusitania."

The performance of the two great high-speed turbine steamers of the Cunard Line continues to be watched with interest, and we give below an abstract of an article in the engineering supplement of the London "Times," in December, by Sir William White, Past President of the Institution of Civil Engineers. These vessels have four screws driven by steam turbines, and it is to be noted that a change from three-bladed to four-bladed screws on two of the shafts has effected an improvement in speed. This change, together with the increased experience in the handling of the machinery, has resulted apparently in a reduced fuel consumption, but the details of this reduction are not made public. The present article supplements a former one by Sir William White which was published in our issue of Sept. 10, 1908.

Since starting from Liverpool on Jan. 23, 1909, the "Mauretania" has made 14 westward passages, covering about 40,000 sea miles between Daunt's Rock and Sandy Hook or Ambrose Channel Lightship. The average speed maintained in all weathers has been 25.44 knots. In the 14 eastward passages made since Feb. 3, the total distance run between the points named has been about 40,500 sea miles, and the average speed has been exactly 25½ knots. Many of the voyages have been made under most unfavorable conditions of wind and sea, and there have been hindrances from fog and thick weather, but the performance of the great ship has been practically uniform. The record is not merely unprecedented, but wonderful; it reflects the greatest credit on the commanding officer, the chief engineer, and the staff of officers and men.

The "Lusitania," between Feb. 7 and the end of October, made 12 westward passages, covering about 34,400 sea miles at an average speed of 24¼ knots. Between Feb. 17 and November it made 12 eastward passages, covering about 34,800 miles at an average of 24 knots. Starting on Nov. 27 from Liverpool, it made a passage at an average of 23.2 knots, but this relatively slow speed was not a real index of the true performance. After the first two hours at a mean speed of 26½ knots, there was a period averaging 19 to 20½ knots, these low speeds being due, no doubt, to special circumstances of weather or machinery. In the next two days a return was made

to true form, and the runs from noon to noon were 637 and 640 miles, respectively, the mean speed rising to 25.58 knots.

Two westward passages made in August and September averaged 25.65 and 25.85 knots; the highest average speed coming eastward has been 25.17 knots. On five consecutive eastward passages (July to October) the average speed has been 25 knots, and on four consecutive westward passages (August to October) 25.2 knots.

The highest average speed attained by the "Mauretania" on a westward passage has been 26.06 knots (end of September), and the highest average speed eastward 25.89 knots (August). On five consecutive westward passages (July-September) the average speed was 25.7 knots, and for five consecutive eastward passages (May-August) the mean speed was 25.75 knots.

When the "Mauretania" was refitted, two four-bladed screws were placed forward, the two three-bladed screws originally fitted being retained in the aftermost positions. This change was made, no doubt, chiefly for the purpose of reducing vibration, and the writer can testify from close personal observation during a voyage from New York in October last that this result has been attained. No objectionable vibration is now experienced at any part of the vessel, and in this respect both ships are now superior to all their rivals on the swift Atlantic passenger service.

While the change of propellers was largely influenced by this consideration, it has undoubtedly been accompanied by an increase in propulsive efficiency; and the improved performance of the "Lusitania," since propellers have been fitted similar to those of the "Mauretania," confirms this view. On the other hand, it is certain that enlarged experience in the management of the propelling apparatus, and especially in the organization of the stokehold arrangements, has been of much greater importance in achieving these remarkable improvements in performance.

A few facts may make the character of the improvement better understood. The best westward trip of the "Mauretania" up to May, 1908, gave an average speed of 24.80 knots; the best trip in 1909 gave an average of 26.06. To this increase in speed corresponds an increase in horse-power of about 25%, supposing the propeller efficiency to have remained the same; and it is known from experimental investigation that the changes made in the propellers have not resulted in an improved efficiency approaching half of that figure. This statement is made with full recognition of the fact that in many instances changes in propellers have resulted in quite as great an increase in speed as has been realized in the "Mauretania," but in these instances the conditions were quite different.

It is not improbable that further experience may lead to still further advance in speed and economy of working, and that even more efficient propellers may be discovered. Reports have been circulated to the effect that new four-bladed propellers are to be fitted aft as well as forward in the "Mauretania." If this is done, the results will be of great interest to shipowners, naval architects, and marine engineers.

But as matters now stand it is satisfactory to know that the anticipations expressed by the writer and others interested in the design of these great ships, that as experience was gained the results obtained on the contract trials of 48 hours' duration would be equalled on the passage across the Atlantic, have been realized; and that adverse criticisms which have appeared in some quarters (more especially in German technical journals) have been shown to be unfounded. It is unnecessary to deal with this part of the subject in any detail, but it may be permissible to remark that instead of having, as was alleged, a superiority in speed of only three-quarters of a knot over the fastest German steamers, the Cunarders have proved themselves to be about 2¼ knots faster, while their greater dimensions secure for them remarkable uniformity in performance in all weathers.

On the voyage homewards in the "Mauretania" made by the writer last October very unfavorable conditions were experienced, yet the big ship made the following daily runs from noon to noon (about 23 hours, allowing for difference of longitude) on four successive days: 582, 593, 579 and 584 miles. On two days there was a heavy following sea on the quarter, and the period of approach of the waves to the ship nearly synchronized with her natural period of oscillation, and consequently tended to produce considerable rolling motion. There was also no little difficulty in keeping on the desired course, because of the action of the strong wind on the high superstructure. Yet in these circumstances the mean speed for the passage was 25.45 knots, and it was only when other vessels were encountered that it was possible to realize the severity of the weather.

In 1908, with the consent of the Cunard company, Mr. Bell gave a summary of the log for the "Lusitania" on the third westerly voyage, when it attained an average speed of 24.25 knots and burnt about 5,000 tons of coal for main and auxiliary propelling machinery between Queenstown and New York, besides 400 tons for the passage from Liverpool to Queenstown and for cooking and auxiliary services.* Naturally the Cunard company does not feel bound to publish the results of subsequent experience and the present rates of coal consumption. Some critics have inferred that this official silence has been maintained because the results have been unsatisfactory. As a matter of fact, it may be stated without breach of confidence that very substantial economies have been obtained, and that the early results given by Mr. Bell, excellent as they were for a beginning, do not represent present practice.

*Engineering News, Sept. 10, 1908.

Cleansing and Disinfecting Dwellings After the Paris Floods.*

The "Permanent Committee of the Superior Council of Hygiene" in France, at its meeting on Jan. 27, 1910, issued instructions regarding the treatment of dwellings which had been flooded in the recent floods of Paris. The instructions are in part as follows:

In any flooded country or any country taking its drinking water from a flooded region, the water necessarily will become so polluted as to be very dangerous to use for some considerable time. To prevent a serious epidemic of typhoid, it is absolutely necessary not to use the water either for drinking or cooking, until it has been boiled. Vegetables, even, which have been covered with the flooded water, should not be used without having been cooked.

It is dangerous to go back to live in a house that has been flooded without having first taken the following precautions:

(1) Remove from the house and from all its appurtenances all mud or dirt which has been deposited by the floods. To facilitate the moving of such mud which has been deposited in great quantities on the ground, it may be dried by covering with lime.

(2) The heaps of dirt or mud which have been removed from the house should be disinfected by mixing with free lime about 5 kg. of lime to 1 cu. m. of mud [8.45 lbs. per cu. yd.]. Care should be taken to move these heaps far from the dwellings.

(3) After moving the heaps from the ground, the earth nearest the buildings ought to be disinfected by dosing it with lime, and the floors inside the dwellings should be washed thoroughly with water.

(4) The walls of the flooded houses should be washed with milk of lime.

(5) Straw mattresses wetted by the floods should be burned and all other cloth in the household should be thoroughly washed and disinfected.

(6) Aeration and ventilation will then be the best means of drying and cleaning the houses. The best method to dry out a house that has been flooded, is to start all the fires and keep them burning very fiercely, at the same time leaving the windows open. The bodies of any animals which have been drowned should be buried immediately and covered with lime.

A Permanent Committee on Epidemics, called by the Prefect of Police, has confirmed the foregoing regulations. It adds that the houses should be drained out as soon as possible. The architects of the city, however, in consideration of the possible effect of rapid emptying of cellars upon the foundations, are opposed to such action and rather desire that the water be allowed to seep out as best it may.

*A free translation of an article in "La Technique Sanitaire" (Paris) for February, 1910.

WATER POURED ON MOLTEN SLAG by accident at the blast-furnace plant of the Dominion Iron & Steel Co., Sydney, N. S., March 19, caused an explosion which blew the roof from one of the company's buildings. Five men were slightly injured.

THE BOILERS OF A TOW BOAT ON THE OHIO River exploded March 14 five miles upstream from Louisville, Ky. One man was killed and two others fatally injured. The boat, known as the "R. L. Aubrey," was owned by the People's Coal Co., of Pittsburg, Pa. Soon after the explosion, the boat sank. The six barges in tow were not injured.

A STRANGE DERAILMENT NEAR GREEN MOUNtain, Iowa, March 21, caused the death of 47 persons and the injury of about 40 others. Two express trains on the Chicago, Rock Island & Pacific Ry., one from Chicago and the other from St. Louis, both bound for Minneapolis, were combined into one train. A freight wreck on the Rock Island line at Shellsburg, Iowa, a few miles north of Cedar Rapids, made it necessary to detour this combined train from Cedar Rapids to Waterloo by way of Marshalltown. The accident occurred while the train was running from Marshalltown to Waterloo over the tracks of the Chicago Great Western Ry. The train consisted of 13 cars and was pulled by two locomotives, both of which, according to press reports, were running backward. Directly behind the locomotives was a Pullman sleeper and this was immediately followed by a smoker and a day coach. In a cut a few miles north of Green Mountain at the top of a grade while running at a speed of 25 or 30 mi. per hr., the tender of the leading locomotive was derailed. The locomotive was turned sharply into the soft clay bank of the cut and stopped short. The second locomotive was likewise ditched and the two together formed a barricade against which the heavy train was rammed by its own momentum. The sudden stoppage due to the proximity of the soft bank made the effect of this derailment at moderate speed more like that of a severe butting collision. The forward Pullman stood the strain well but the smoker and day coach which were the second and third cars of the train, were crushed together and very few of their occupants escaped serious injury. The last ten cars of the train were little injured.

A VERY FAST RUN is reported on the Lake Shore & Michigan Southern Ry. on March 1. The "Twentieth Century Limited" train made the run over the division from Toledo to Elkhart, 133 miles, in 113 minutes. The train made one slow-up, but maintained an average speed from terminal to terminal of 70.6 miles per hour. The run from Kendallville to Elkhart, 42 miles, was made in 32 minutes, or at an average speed of 78.7 miles per hour. These are official figures taken from the train dispatcher's sheets and are furnished to us through the courtesy of the railway officers.

THE STEAMSHIP "MAURETANIA" of the Cunard line, opened its 1910 season of record-breaking performances with the trip ending at New York on March 17. The best record for westbound trips over the long, or winter, course had previously been 4 days 15 hrs. 55 min.; it is now 4 days 15 hrs. 29 min. This indicates an average speed of 25.91 knots, which is a new record. The best day's run on the trip was at a speed of 26.79 knots, which figure does not equal the best previous record of 27.30 knots.

COSTS OF WARSHIP MACHINERY in Great Britain have enormously increased in the past 20 years according to a review in "The Engineer" of March 11. We quote as follows:

The average cost per ton for the propelling machinery in the "Majestic" class was just under £66, and sprang immediately to £92 in the "Canopus" class, where the Belleville boiler first made its appearance. In the "Bulwark" and "Queen" classes it was about £105; in the "Exmouths" about £110, rising to nearly £117, as the average of the "King Edwards." In the first four "Dreadnoughts" the price exceeded £145 per ton. Taking the cruisers, we get similar figures, each class representing an almost continual advance on its predecessors. Thus the "Powerfuls" cost £85 per ton of machinery, the "Diadems" £98, the "Cressy" class just over £100, "Good Hope" over £114, and the earlier "County" class £130. With their completion the country reached a period when prices of material declined slightly, and in the succeeding classes prices dropped to £114 in the case of the "Natal" type, rising again to £120 in the "Shannon" class, and attaining the gigantic figure of £151 per ton of machinery in the "Inflexible" class. In small cruisers and scouts the cost in recent years has advanced from £120 in the "Pelorus" type to £176 in the "Amethyst," and about £192 in the "Scout" class. Destroyer machinery is even more expensive; in the first ocean-going turbine destroyers it cost more than £245 per ton, but in the boats of the last two years prices have fallen to about £195 per ton. These figures are truly appalling, but there are adequate reasons why they are so high. One is the increase in cost of fuel—of oil at 80s. a ton, as it was at that time, in place of coal at 20s. Compared with the amounts paid abroad for warship engines, the public have every reason, even if the manufacturers have not, to be thoroughly satisfied with the prices at which the Admiralty is now able to obtain its machinery.

Translating the English figures and weights into American money, it appears that the battleship machinery of 20 years ago, before the advent of the water-tube boiler, cost about 14 cts. per lb. The machinery for the first "Dreadnoughts" built only about three years ago cost 31 cts. per lb., while the propelling machinery of the first ocean-going turbine driven torpedo boat destroyers cost 53 cts. per lb.

DEVICES FOR THE PREVENTION OF ACCIDENTS are to be awarded five prizes amounting to a total of $5,790 in an international competition to be held under the auspices of the Italian ministry of agriculture, industry and commerce. Entries must be made before Dec. 31, 1911. Copies of the decree announcing the competition, printed in French, may be obtained from the U. S. Bureau of Manufactures, Washington, D. C.

CEMENT DELIVERIES AT PANAMA.—Concrete laying at Gatun locks, and in the spillway of Gatun Dam, requires 3,300 barrels of cement daily, in order to permit the mixing plants to run at their present rate. It is estimated that 1,500 barrels of cement daily will be required in the concrete work at Pedro Miguel Locks by April 15, and that 3,000 barrels a day will be required after May 15. During the present month, the steamers "Ancon" and "Cristobal" will bring 50,000 barrels each to the Isthmus, and 10,000 barrels will be delivered by other Panama railroad vessels.

At present the cement ships "Ancon" and "Cristobal" can make only one round trip voyage a month between New York and the Isthmus, due in part to the time required in loading and unloading cargo at the termini. In order to shorten the time required at Cristobal, mechanical cement unloaders were contracted for. A committee, appointed to suggest means for putting the unloaders in operating condition at the earliest possible moment, conducted a test on March 1 of one of the barrel unloaders erected on Dock 11. The test was made on the cargo of

the "Cristobal," and a few changes will be necessary in the apparatus before it can do the work satisfactorily. These changes are being made, and another test will be made on the cargo of the "Ancon," when the boat arrives. —"Canal Record," March 9.

EXCAVATION RECORD IN CULEBRA CUT.—More material was dug out of Culebra Cut during February than in any other February since the canal work was begun. A comparison follows:

1905	75,200
1906	168,410
1907	639,112
1908	1,248,265
1909	1,215,648
1910	1,259,413

The daily average of excavation in February was 54,757 cu. yds., which is the highest daily average for this month. The average per steam shovel was also the highest of record, and the daily average of 2,203 cu. yds., made by shovel No. 214, is the best yet made.—"Canal Record," March 9.

STEAM SHOVEL RECORDS AT PANAMA.—On Saturday, March 5, 1910, shovel 213, working in the Culebra Construction District of the Central Division, broke all records for daily excavation since the commencement of work by the United States. During the working day of eight hours, that shovel excavated 4,000 cu. yds. of rock and earth, loading 211 Lidgerwood flats with the material removed. The shovel was under steam eight hours, was actually digging seven hours, and was waiting for cars, etc., one hour.

On Saturday, March 5, 1910, sixteen shovels, working in the Culebra Construction District of the Central Division, excavated 26,152 cu. yds. of rock and earth during the working day of eight hours, an average of 1,635 cu. yds. per shovel for the day. The material was loaded into 1,258 Lidgerwood flats and 225 small Western and Oliver dump cars, a total of 1,483 carloads. The shovels were under steam 128 hours, actually digging 83 hours and 50 minutes, waiting for cars 32 hours and 55 minutes, and mining, clearing track, undergoing minor repairs, etc., for the balance of the time.—"Canal Record," March 9.

PETROLEUM PRODUCTION in the United States during 1909 is summarized as follows by the United States Geological Survey:

Field.	1909. Barrels.	1908. Barrels.
Appalachian	27,000,000	24,945,517
Lima-Indiana	8,300,000	10,032,305
Illinois	28,200,000	33,685,106
Mid-Continent	43,300,000	48,323,810
Gulf	13,200,000	17,318,330
California and Rocky Mountain States	58,000,000	45,267,411
	178,000,000	179,572,479

A PUMPING STATION 4200 FT. FROM ITS POWER plant has been installed to supply water for the Macon shops of the Central of Georgia Ry. Motor driven pumping equipment was installed on the bank of the Ocmulgee River and the required supply of 600,000 gals. per 24 hours is now obtained at a less cost than when the water was purchased. The pumps are controlled from a switchboard at the power plant nearly a mile away and no attendant is maintained at the pump house.

The pumping station is a circular structure and contains three motor-driven, horizontal-shaft, single stage turbine pumps. Each pump unit has a capacity of 1,200 gals. per min. and is driven by a direct-connected, 2,000-volt, three-phase, 60-cycle induction motor delivering 40-HP. at 1120 r.p.m. Current for the motors is supplied by mains from the shop's power plant. The selection of impeller pumps was made necessary by the large quantities of sediment and sand in the river water. Bronze impellers and bronze diffusion vanes are used to secure the best possible durability and efficiency under these conditions.

The suction line is led from a screened intake well and the pumps discharge into a 16-in. main leading to a reservoir at the shop whose level is 55 ft. above the normal stage of the river. The water from the reservoir is used in the power station condenser, and that portion of the condenser overflow which is needed is then filtered and treated for use in the boilers.

The regulation of the electric pumps is effected by means of independent supply circuits for each machine. This arrangement was found to be simpler and very little more expensive than automatic starters at the pump house with control circuits to the power house. The starting panels are equipped with ammeters showing the current consumed by each unit and a graphic recording wattmeter in the main circuit which records the total power used. As an approximate constant relation exists between the water discharged by the pumps and the power taken to drive them, the recording meter affords a convenient means of totalling the amount of water pumped. The starting panels carry also a graphic gage indicating the water level in the reservoir, by watching which the power house attendant can regulate the pump delivery to the rate required. A motor driven valve in the main entering the reservoir, operated from a controller on the switchboad, completes the concentration of control of the entire pumping system at these panels.

The electrical equipment for this pumping plant was furnished by the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa., and was installed under the direction of Mr. E. M. Rhett, Electrical Engineer for the Central of Georgia Ry.

A PLAN TO REDUCE TERMINAL EXPENSES in New York City is being furthered by the Bush Terminal Co., of 100 Broad St., and is of interest in connection with the editorial on terminal expenses in our issue of March 3. We quote from a statement issued by the Bush Co., as follows:

The recent suggestion for the establishment of union stock and shipping rooms in New York City, conducted for any number of manufacturers, by a common agent on a semi-cooperative basis, is commented on as follows by President Irving T. Bush, of the Bush Terminal Co.

Generally, the plan is not considered in the light of a revolutionizing innovation. It is rather looked upon as the logical outgrowth of the cooperative tendency as manifested in union passenger and freight depots. The assumption is, of course, that a union shipping room must be located in the immediate vicinity of a union freight depot, and similar shipping facilities.

Many out-of-town manufacturers are to-day maintaining individual stock and shipping rooms in New York City at a disproportionately great cost. Hundreds of others, on the other hand, are compelled to forego the advantages of metropolitan representation on account of the financial risks involved. In such a union stock and shipping room one trained force of clerks would be able to perform all the work required.

That the public would be immensely benefited by the establishment of union freight stations, there can be no question. It needs but a moment's consideration to realize the economy which would accrue to the manufacturer or merchant if he could make all of his freight shipments from one station instead of carting them in separate vehicles to a great number. While in Manhattan borough they cling tenaciously to separate receiving stations for each road, Brooklyn is served by union freight stations for all roads. The Bush Terminal Company is a sample of this service. There a manufacturer and shipper may send his cart loaded with freight shipments for ten railroads to one union freight station. He receives his bills of lading in exactly the same manner as though he made his deliveries to ten different points. The shipments are sorted, and sent out over the lines of ten different railroads without further trouble or expense to him.

Many manufacturers and shippers who require a distributing headquarters in New York both for local business and for shipments to territory tributary to that center, are put to the expense of hiring stock rooms and maintaining a force of shipping clerks and bookkeepers, whose services are actually required only a small portion of each day. The duties of a shipping clerk are not materially different in handling one class of product or another. This is shown by the fact that the moment a package passes from the shipping room to the railroad the same intelligence handles an infinite variety of articles. The idea with which these union stock rooms could be established has the same underlying principle of cooperative economy which has been instrumental in reducing operating costs in other lines.

Manufacturers and wholesale dealers who require a central shipping point in New York City will find that through the economy, first, of a freight station acting for all of the railroads; second, union shipping buildings on terminal tracks of all of the railroads, and, third, union stock rooms conducted upon the principle of cooperation, they can enjoy each, for a few hundred dollars, better facilities than they are now paying thousands to maintain.

AEROPLANISTS OF THE WORLD will be invited to compete at a grand meet at the City of Mexico in September, 1910. This is planned as one feature of a centenary celebration and prizes aggregating from $50,000 to $100,000 will be offered, according to a recent note in the "Bulletin" of the Bureau of American Republics.

ELECTRICITY IN RUSSIA.—Mr. S. W. Cuttriss in "Electrical Engineering" (London) of Jan. 27 states that in the Russian Empire there are only 30 cities with electric street-railway lines, and that only 886 out of the 1802 towns are lighted at all. Of these 74 have electric lamps and 35 use gas. The telephone is used in only 15 cities. A great boom in electricity works is expected in the next few years as the net profits of the few central stations have been good, varying from 33% to 50%.

Personals.

Capt. John H. Poole, Corps of Engineers, U. S. Army, has resigned and his resignation has been accepted, effective March 28.

Mr. J. C. Galbreath has been appointed Division Engineer of the National Rys. of Mexico with headquarters at San Luis Potosi.

Mr. Ernest McCullough has resigned from the editorial staff of "Engineering Contracting" and is now one of the editors of the "Railway Age Gazette."

Mr. L. F. Van Hagan, Assistant Engineer of Maintenance-of-Way of the National Rys. of Mexico, has been appointed Bridge Engineer with headquarters at Mexico City.

Mr. C. O. Nordensson has resigned his position in charge of the gas-producer department of the Fairbanks-Morse Co., to take a position with the Gibbs Gas Engine Co., of Atlanta, Ga.

Maj.-Gen. Thomas H. Barry, U. S. Army, has been designated as Superintendent of the Military Academy at West Point, to succeed Col. H. L. Scott. The change is to take place Aug. 31, 1910.

Mr. Frank B. Harriman, General Manager of the Illinois Central R. R., has resigned that position and its duties will be assumed by Mr. W. L. Park, who recently became Vice-President of that road, as noted in our last week's issue.

Mr. L. H. Conklin, M. Am. Inst. E. E., recently General Manager of the Scranton Electric Co., of Scranton, Pa., has been made an engineer in the operating department of J. G. White & Co., of New York City. Mr. Conklin is a graduate of Pratt Institute, Brooklyn, N. Y., class of 1891.

Mr. Walter R. Okeson, Assistant Engineer of the Phoenix Bridge Co., at Phoenixville, Pa., for the past ten years, has been appointed Resident Engineer of the Phoenix Bridge Co. and the Phoenix Iron Co., at New York City, succeeding Mr. Seymour P. Thomas, resigned. Mr. Okeson will take up his new duties in New York City April 1.

Mr. Andrew D. Chidsey, Jr., formerly Resident Engineer on grade crossing elimination in Wilkesbarre, Pa., for the Lehigh Valley R. R., who has been in charge of the reconstruction of the Manheim plant of the Alpha Portland Cement Co. during the past year, has opened an office as a designing and constructing engineer in the Northampton National Bank Bldg., Easton, Pa.

Mr. A. M. Shaw, Assoc. M. Am. Soc. C. E., has resigned his position as an expert in drainage investigations, U. S. Department of Agriculture, and has taken charge of the reclamation work of the Phillips Land Co. as Engineer and Resident Manager, with headquarters at New Orleans, La. Mr. John M. Egan, Jr., of Amboy, Ill., will be put in charge of the work on the Inlet Swamp Drainage District, Lee County, Ill., which was formerly under Mr. Shaw's supervision.

Obituary.

A. F. Sortwell, President of the Montpelier & Wells River R. R., died March 21 at his home in Cambridge, Mass. Mr. Sortwell was Treasurer of the Columbia Water Power Co., of South Carolina, and was Mayor of Cambridge in 1897-'98.

Henry Bride Scholes, founder of the South Brooklyn Iron Works, died March 16 at his home in Brooklyn, N. Y., aged 83 years. He was born in London, England, but was brought to this country by his parents at the age of two years.

Earl R. Hack, Manager of the Baltimore & Ohio R. R.'s electric plant at Brunswick, Md., died at that place March 13 as the result of an electric shock sustained while repairing wires on a pole. Mr. Hack was 24 years old and was a graduate of the course in electrical engineering at Cornell University in the class of 1908.

Maurice Hutin, formerly President of the New Panama Canal Co., died March 16 at Paris, France. Mr. Hutin came to the United States from Paris early in 1900, shortly after his election as President of the New Panama Canal Co., and conducted the negotiations ultimately leading to the purchase of that company's rights, property and unfinished work by the United States Government.

Commodore William George Hovgaard, of the Danish navy, who was formerly Professor of naval architecture at the Massachusetts Institute of Technology, died March 16 at Copenhagen, Denmark. Commodore Hovgaard came to the Massachusetts Institute in 1901 and helped to build up the department of naval architecture. He retained his position on the faculty of the institute until about two years before his death when he returned to duty in the Danish navy. Early in his career he attained distinction as an arctic explorer.

Theodore Schoonmaker, a civil engineer of Leavenworth, Kan., died Jan. 29 in San Antonio, Tex., from injuries received in a fall. Mr. Schoonmaker, who was 75 years old, slipped and fell while walking in the Alamo plaza with his daughter, an abdominal blood vessel burst and his death followed within an hour. He had gone to San Antonio with his family to spend the winter. Mr. Schoonmaker was employed some years ago on the location of 400 miles of the Northern Pacific Ry. and on the location of the Chicago, Rock Island & Pacific Ry., from Davenport, Iowa, to St. Joseph, Mo.

Gardiner C. Sims, M. Am. Soc. M. E., President of the Wm. O. Harris Steam Engine Co., of Providence, R. I., died March 19 at his home in that city after an illness of several weeks duration. Mr. Sims was born at Niagara Falls, N. Y., in 1845 and was educated in the schools of that village. His earliest employment after leaving school was as a machinist apprentice in the West Albany shops of the New York Central & Hudson River R. R. Afterward he served for three years as a draftsman in the engineer department of the U. S. Navy and his next position was that of Superintendent of the J. C. Headley Engine Works. He was subsequently a member of the firm of Armington & Sims, which was the first to make a commercial success of an automatic high-speed engine.

Engineering Societies.

COMING MEETINGS.

AMERICAN WATER WORKS ASSOCIATION.
April 26-30. Annual convention at New Orleans, La. Secy., J. M. Diven, 14 George St., Charleston, S. C.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 5-7. Annual meeting at Pittsburg, Pa. Secy., Jos. W. Richards, South Bethlehem, Pa.

APPALACHIAN ENGINEERING ASSOCIATION.
May 6-7. Annual meeting at Winston-Salem, N. C. Secy., Henry M. Payne, Morgantown, W. Va.

AIR BRAKE ASSOCIATION.
May 10. Annual meeting at Indianapolis, Ind. Secy., F. M. Nellis, 53 State St., Boston, Mass.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
May 16-20. Annual meeting at Los Angeles, Cal. Secy., P. W. Drew, Room 306, 135 Adams St., Chicago, Ill.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 17-19. Annual meeting at Chicago, Ill. Secy., Franklin H. Wentworth, 87 Milk St., Boston, Mass.

AMERICAN RAILWAY ASSOCIATION.
May 18. Annual meeting at New York City. Secy., W. F. Allen, 24 Park Pl., New York City.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
May 19-20. Semi-annual meeting at Cincinnati, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 23-26. Annual meeting at Chicago, Ill. Secy., D. B. Sebastian, 327 La Salle Station, Chicago, Ill.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 23-28. Annual meeting at St. Louis, Mo. Secy., T. C. Martin, 29 West 39th St., New York City.

CALIFORNIA STATE IRRIGATION CONVENTION.—A convention will be held at Stockton, Cal., April 16 for the purpose of discussing the different methods of constructing and operating irrigation systems in use throughout the state. The secretary is Mr. J. M. Eddy, Chamber of Commerce, Stockton, Cal.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The regular April meeting will be held in the Engineering Societies' Building in New York City, April 15, under the auspices of the institute's educational committee. Dr. Samuel Sheldon, Professor of Physics and Electrical Engineering at the Brooklyn Polytechnic Institute, will present a paper on "Education for Leadership in Electrical Engineering."

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—The second annual convention and exhibition will be held at London, Ont., March 28-April 1. Among the papers to be presented are the following:

March 29.—Presidential address by Peter Gillespie, University of Toronto; "The Use of Concrete in Dwelling House Architecture," Ernest Wilby, Detroit, Mich.; "Waterproofing of Concrete," R. A. Plumb, Detroit, Mich.; "The Use of Cement in Architecture," F. S. Baker, Toronto, Ont.; "Inexpensive Homes of Concrete," Milton D. Morrill, Washington, D. C.

March 30.—Discussion of Proposed Standard Specifications; "Concrete Bridges," A. W. Connor, Toronto, Ont.; "An Analysis of Concrete Bridge Failures," C. R. Young, Toronto, Ont.; "Concrete Roadway Construction," C. W. Boynton, Chicago, Ill.; "Concrete Pavements," James Pearson, Toronto, Ont.

March 31.—"Some Experiments With Cement Tile," W. H. Day, Guelph, Ont.; "The Uses of Concrete on the Farm," Philip L. Wormeley, Washington, D. C.

NATIONAL CONFERENCE ON CITY PLANNING.—The second national conference on city planning and problems of congestion will be held at Rochester, N. Y., May 2-4. It is announced that at this conference generalities will be carefully avoided. The aim will be to discuss thoroughly particular phases of each selected subject rather than to wander through the whole field. The two sessions on May 3 will be devoted to the consideration of the congestion of population: causes of congestion will be taken up at the morning session and measures for prevention at the afternoon session. Among those who will speak on this subject are Warren H. Manning, Boston, Mass.; Edward T. Hartman, Boston, Mass.; Benjamin C. Marsh, New York City; and Geo. E. Hooker, Chicago, Ill.

The topic for the morning session, May 4, will be the circulation of passengers and freight. Among the speakers will be Nelson P. Lewis, New York City; Geo. R. Stearns, Philadelphia, Pa.; and Calvin Tomkins, New York City. Problems of legal and administrative procedure affecting the city plan will be discussed at the afternoon session, May 4, and among those expected to speak on this subject are Bolton Hall, New York City; Frederick L. Ford, Hartford, Conn.; and Jos. W. Shirley, Baltimore, Md.

The secretary is Mr. Flavel Shurtleff, 19 Congress St., Boston, Mass.

INTERNATIONAL CONGRESS OF MINING, METALLURGY, APPLIED MECHANICS AND PRACTICAL GEOLOGY.—A provisional program has been issued for the coming meeting at Düsseldorf, Germany, June 19-23. Simultaneous sessions will be held by four separate sections corresponding to the four technical branches set forth in the name of the congress. A few of the more interesting looking titles of papers are given below:

Mining section.—"The Hydraulic Blasting Pump and Its Performance"; "Sinking Concrete Mine Shafts"; "Use of Reinforced Concrete in Mine Workings"; "To What Extent Are Infectious Diseases Spread by Mining Operations"? "Utilization of Low Grade Fuels"; "Development of Fans and Compressors in the German Mines."

Metallurgy section.—"Present Status of the Converter Process in Germany"; "Present Status of the Ore Briquetting and Agglomerating Process in Germany"; "Progress of the Autogenous Welding Processes in Germany"; "A New Method for the Preparation of Iron Ores," by Professor Mathesius, of Charlottenburg; "Relative Economy of the Various Ways of Driving Steel-Works Blowing Engines"; "Influence of Galvanizing on the Strength of Wire."

Applied mechanics section.—"Recent Experience in Gas Engine Operation"; "Installations for the Utilization of Exhaust Steam" and "Turbo Compressors," by Professor Rateau, of Paris (inventor of the Rateau steam turbine); "New Methods of Mine Pumping."

Practical geology section.—"The Radium Deposits and the Probable Development of the Radium Market"; "The Unique Mineral Resources of Canada," by H. Mortimer-Lamb, of Montreal, Que.

Among the several excursions planned for the congress is a visit to the World's Exposition at Brussels.

All papers will be presented in French, German or English, and will be printed in the proceedings in the language in which they are presented, together with abstracts in the other two authorized languages.

The name and address of the committee of organization of the congress is Arbeitsausschuss des Internationalen Kongresses Düsseldorf 1910, Düsseldorf, Jacobi-Strasse 3/5. The fee for registration as a member in any section of the congress, which entitles one to attend the sessions and receive the printed papers, is $5.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the regular monthly meeting, March 15, a paper on the "Floods in the River Seine," was read by Mr. Thomas P. Roberts of the U. S. Engineer's Office, Pittsburg. The author pointed out the peculiar soil conditions in the Seine basin tending usually to restrain floods but occasionally tending to prolong and increase the volume of their discharge. He made very interesting deductions from the accompanying table:

Rivers.	Area of basin. sq. mi.	Cu. ft. per sec. Approx. high water.	Usual low water.	Extreme low water.	Discharge, sec.-ft. per sq. mile of water shed. High water.	Usual low water.	Extreme low water.
Seine above Paris	15,000	60,000	2,640	1,200	4.00	0.176	0.080
Monongahela above Pittsburg	7,391	160,000	400	175	21.65	0.054	0.024
Ohio at Pittsburg	18,644	350,000	2,500	1,400	18.77	0.134	0.075

Note: In March, 1907, the Monongahela reached a discharge of 230,000 cu. ft., and the Ohio at Pittsburg, 430,000 cu. ft. per sec. Mr. Roberts said that during the late Paris flood the Seine at Paris probably reached or exceeded a discharge of 100,000 cu. ft. per sec., but the article on the first page of this issue shows the flow to have reached only 85,000.

Mr. Roberts referred to the very permeable nature of the soil in the Seine basin, three-quarters of its area being chalk, which gives rise to countless springs, and pointed out that these conditions, together with the Marne and other "equable" tributaries of the Seine are capable in the aggregate of keeping up a long protracted medium flood stage at Paris, which, in 1876 lasted 55 days, owing to the very slight slope of the Seine below Paris, preventing a rapid carrying away of the water.

The author pointed out that owing to these conditions there arises at long intervals possibility of serious disasters in the Seine valley which is unusually level.

During these weeks of high water to which the chalk country may furnish a large and persistent volume, a second rain storm may traverse the Yonne country, the bad third of the Seine basin, which is an elevated wooded region with extensive exposures of limestone where, in places, rain water rapidly sinks to reappear in notably large springs. This local rainfall may not be very great but it furnishes a sudden and sufficient increment on top of the medium flood to bring about gravely serious conditions.

Referring to suggestions made for governing flood conditions in France, by means of reservoirs, the author pointed out that Nature is now illustrating at Paris one of the possible mishaps attending the use of reservoirs, as the chalk and gravel beds forming splendid reservoirs are letting out too much water which cannot be controlled; for it is probably the case that owing to the nature of the soil and topography few sites can be found for large artificial reservoirs.

The matter of forestation was commented on as were the projects looking to the enlargement and shortening of the Seine from Paris to the sea.

BOSTON SOCIETY OF CIVIL ENGINEERS.—The annual meeting and dinner of the Boston Society of Civil Engineers was made an all-day function of a social character, and was held at the Boston City Club on Wednesday, March 16, 1910. The annual meeting was called to order at twelve o'clock noon with the President, Mr. George F. Francis, of New York, in the chair. The annual reports of the board of government and the several officers and committees of the society were received. It appears that the total membership is 723 at the present time, in comparison with 678 at the annual meeting of last year. The average attendance at the meetings of the society has been 138 and at those of the Sanitary Section, 40. From the treasurer's report, it appears that the permanent fund of the society now amounts to approximately $26,000, but that the balance of current funds is only about $400, and that there was an excess of expenditures over receipts in current funds amounting to a trifle over $300 in the course of the year. The committee on a society house, reported on the attempts which had been made during the year to secure a permanent home for the society, and which have thus far not resulted in anything conclusive, or very encouraging. A certain property was examined and requests for contributions were sent out, with a view towards its purchase, but not enough subscriptions were received to warrant proceeding with the project.

The members of a joint committee on an engineers' clubhouse, which were appointed in pursuance of the vote at the Boston Engineers' dinner on January 21, 1910, reported informally upon the project which is now being canvassed by the joint committee. About a dozen societies are represented in the joint committee and it is probable that a number of others will come into the project, if it is carried through. The societies represented include, besides the Boston Society of Civil Engineers, the American Society of Mechanical Engineers, the Boston Section of the American Institute of Electrical Engineers, New England Water Works Association, New England Association of Gas Engineers, National Electric Light Association, Illuminating Engineering Society, Boston Society of Architects, New England section of the American Chemical Society, and the Society for Chemical Industry. A tentative ideal scheme contemplates the erection of a ten-story building, somewhere between Park Sq. and Copley Sq., fronting on a business street, and with the other end upon a quieter street. The plan contemplated dividing this building into two sections, which might be called the commercial and the club section, the latter of course fronting upon the quiet street. The scheme involved the formation of an engineers' club, having a resident membership of about 1,000, and annual dues of $50. This club would be a first-class club in every way, with all the usual accessories, and would in a sense be the principal organization to support the building. The commercial part would be used in its upper floors by the various engineering and scientific societies, which would have a joint library with separate alcoves for the collections belonging to the different societies. There would also be a large auditorium, and direct connection with the large banquet hall of the club. The lower floors would be rented for business purposes. The joint committee has appointed a standing committee (Mr. C. L. Edgar, President of the Edison Electric Illuminating Co., Chairman) which is trying to work out the details of a scheme along these lines. Every member of the joint committee appears to be enthusiastic on the project, and there are considerable probabilities that something may come of it. Within a short time the committee will send out letters to the various societies, asking whether they would desire quarters in such a building and to individuals, to find out what support the proposed club would receive.

The tellers of election submitted their report, showing the election of the following officers:

President, Henry F. Bryant, of the firm of French & Bryant, Brookline.
Vice-President, James W. Rollins, Jr., of Holbrook, Cabot & Rollins Corporation.
Secretary, S. E. Tinkham.
Treasurer, Charles W. Sherman.
Librarian, Frederick I. Winslow.
Director, Frank A. Barbour.

These, with Vice-President Charles T. Main and Director F. H. Fay, whose terms have not expired, constitute the Board of Government for the ensuing year. President George B. Francis then delivered the president's annual address upon the progress of the society and upon its needs, as he saw them. He particularly recommended that attention be given to the following points: (1) An increase in the membership dues; (2) raising the qualifications for membership and perhaps dividing the membership into different grades, substantially corresponding to those of the American Society of Civil Engineers; (3) the necessity for permanent quarters; (4) the desirability of publishing an independent journal.

At 2.30 p. m. the annual dinner was served in the large auditorium of the Boston City Club. After the dinner, Past-President, John R. Freeman, of the society, delivered a most interesting address upon the Los Angeles aqueduct, profusely illustrated by lantern slides.

The evening was devoted to an informal smoker, with frequent songs, many of which had been written for the occasion. The day was in every way successful and was much enjoyed by all present. This is the second year when this plan of holding the annual meeting and dinner has been followed.—Charles W. Sherman.